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(51) International Patent Classification ⁶ : C11D	A2	(11) International Publication Number: WO 98/16604 (43) International Publication Date: 23 April 1998 (23.04.98)
(21) International Application Number: PCT/US97/18426 (22) International Filing Date: 14 October 1997 (14.10.97) (30) Priority Data: 60/028,496 15 October 1996 (15.10.96) US (71) Applicant (for all designated States except US): THE PROCTER & GAMBLE COMPANY [US/US]; One Procter & Gamble Plaza, Cincinnati, OH 45202 (US). (72) Inventor; and (75) Inventor/Applicant (for US only): GREEN, Phillip, Richard [US/US]; 540 Compton Road, Wyoming, OH 45231-5006 (US). (74) Agents: REED, T., David et al.; The Procter & Gamble Company, 5299 Spring Grove Avenue, Cincinnati, OH 45217 (US).		(81) Designated States: BR, CA, CN, JP, MX, TR, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>Without international search report and to be republished upon receipt of that report.</i>
(54) Title: DETERGENT COMPOSITIONS CONTAINING ISOPEPTIDASE (57) Abstract Cleaning compositions, preferably laundry detergent compositions, comprising an isopeptidase enzyme having the ability to catalytically cleave the isopeptide bond between the glutamine gamma-carboxamide and lysine epsilon-amino group.		

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DETERGENT COMPOSITIONS CONTAINING ISOPEPTIDASE

CROSS REFERENCE

This application claims priority under Title 35, United States Code 119(e) from Provisional Application Serial No. 60/028,496, filed October 15, 1996.

FIELD OF THE INVENTION

The present invention relates to cleaning compositions comprising an isopeptidase enzyme, preferably a laundry detergent composition. Preferred laundry compositions are in granular form. More particularly, the invention is directed to detergent compositions containing an isopeptidase enzyme, deterative surfactant and builder (e.g., aluminosilicate, silicate), preferably in combination with deterative enzyme (e.g., proteases, lipases, amylases, cellulases).

BACKGROUND OF THE INVENTION

Most conventional detergent compositions contain mixtures of various components, typically including enzymes which have cleaning properties. Commonly encountered deterative enzymes commercially used in laundry compositions include proteases, amylases, cellulases, and lipases. In addition, the literature is full of a vast array of other classes of enzymes investigated for use in cleaning compositions. However, very few of these have advanced beyond the initial evaluation stage to be used in commercial compositions. Obvious technical challenges for commercial use of any enzyme in cleaning compositions include compatibility with other common cleaning components (e.g., surfactants; builders; other enzymes), stability and effectiveness at typical storage and use pH, and availability, just to name a few.

One class of enzymes which has not been previously investigated for utility in cleaning compositions is known as isopeptidases. The first of this class of enzymes has been recently identified, following detection of novel enzymatic activity in the salivary gland secretion of the medicinal leech whereby the isopeptide bond between the glutamine gamma-carboxamide and lysine epsilon-amino group is split [see, for example, Fradkov et al., "Enzyme from the medicinal leech (*Hirudo medicinalis*) that specifically splits endo- ϵ (- γ -Glu)-Lys isopeptide bonds: cDNA cloning and protein primary structure", FEBS Letters, 390 (1996) 145-148]. This enzyme (called "destabilase") specifically splits isopeptide crosslinks in stabilized fibrin chains, but leaves the polypeptide chains intact, thereby liquefying stabilized

fibrin in vitro. Based on this enzymatic activity, which reverses the final step in blood coagulation, isopeptidases are currently being studied for possible use as thrombolytic agents.

It has now been determined that such activity is useful in cleaning processes where certain body soils are desired to be removed. This includes laundry processes whereby typically stubborn body soils and stains are sought to be removed. One such body soil or stain material sought to be removed are fragments which resist, in part, removal by detergents and proteases due to the chemically stable endo- ϵ (γ -Glu)-Lys isopeptide bonded cross links found in the cornified envelope of stratum corneum (skin) cells, from which is derived some or all of such body soils and stains on fabrics to be cleaned. Such troublesome soils and stains (which may be comprised in part of endo- ϵ (γ -Glu)-Lys crosslinked proteins) are typically found on garments in the area of collars and cuffs, as well as in undergarments. It is therefore an object of the present invention to provide cleaning compositions and methods which utilize isopeptidase enzymes.

BACKGROUND ART

Finot, P.-A., Mottu, F., Bujard, E. and Mauron, J. (1978) Adv. Exp. Med. Biol. **105**, 549-570, demonstrated a γ -Glutamyl- ϵ -lysine hydrolytic activity in rat kidney extract. Baskova, I. P., and Nikonov, G. I. (1985) Biokhimiya **50**(3), 424-431, reports leech destabilase mechanism (hydrolysis of γ -Glutamyl- ϵ -lysine) for liquefying fibrin, including kinetics on the artificial substrate γ -Glutamyl-pNA. [See also, Baskova, I. P., and Nikonov, G. I. (1991) Blood Coagulation and Fibrinolysis **2**, 167-172, which contains kinetics on additional substrates.] Fradkov, A., Berezhnoy, S., Barsova, E., Zavalova, L., Lukyanov, S., Baskova, I. and Sverdlov, E. D. (1996) FEBS Letters **390**, 145-148, describes the cloning and sequencing of destabilase. See also: Baskova, I. P., Nikonov, G. I., "Destabilase: An Enzyme in the Salivary Gland Secretion of Medicinal Leech - Hydrolyzes Isopeptide Bonds in Stabilized Fibrin", Biokhimiya, Vol 50(3), 1985, pp. 424-431; Baskova, I. P., Nikonov, G. I., Zavalova, L. L., and Larionova, "Kinetics of the Hydrolysis of L- γ -Glu-pNA by Destabilase, an Enzyme from the Leech *Hirudo medicinalis*", Biochimiya, Vol 55(4), pp 674-479 (1990).

Hoshino, E., Maruta, K., Wada, Y. and Kazuo, M. (1995) JAOCS **72**(7), 785-791, describes the interaction of highly purified alkaline protease from *Bacillus* sp. KSM-K16 (K16 protease said to have been isolated for use in laundry detergents) with the horny cells of human skin contained in skin grime as observed by electron microscopy. This protease is said to first penetrate the horny cells and

then adsorbs, mainly onto the internal structure of the cells at the initial stage of hydrolysis, and directly hydrolyze the keratin filaments.

SUMMARY OF THE INVENTION

According to the present invention there is provided a cleaning composition (preferably laundry detergent compositions, e.g., for use in laundry machine washing or presoak compositions)) comprising an isopeptidase active amount of isopeptidase enzyme.

Preferred are laundry detergent compositions comprising:

- a) from about 0.0001% to about 5% (preferably from about 0.001% to about 2%) by weight of an isopeptidase enzyme; and
- b) from about 95% to about 99.9999% by weight of detergent composition adjunct ingredients.

The present invention is also directed to laundry detergent compositions comprising:

- a) from about 0.1% to about 80% (preferably from about 1% to about 50%) by weight of deterative surfactant;
- b) from about 0.0001% to about 5% (preferably from about 0.001% to about 2%) by weight of an isopeptidase enzyme; and
- c) from about 0.1% to about 99.8% by weight of detergent composition adjunct ingredients, preferably including from about 0.1% to about 80% of builder (e.g., aluminosilicates, silicates, phosphates, phosphonates, etc.). Preferred compositions are in granular form.

The present invention is further directed to detergent compositions comprising:

- a) from about 0.0001% to about 2% by weight of active deterative enzyme (preferably selected from the group consisting of proteases, cellulases, lipases, amylases, peroxidases, and mixtures thereof);
- b) from about 0.0001% to about 5% (preferably from about 0.001% to about 2%) by weight of an isopeptidase enzyme; and
- c) from about 0.1% to about 99.8% by weight of detergent composition adjunct ingredients (preferably selected from deterative surfactants and/or builders).

Preferably, these detergent compositions comprise one or more deterative surfactants selected from: anionic surfactants, preferably selected from the group of alkyl alkoxylated sulfates, alkyl sulfates, and/or linear alkyl benzenesulfonate surfactants; cationic surfactants, preferably selected from quaternary ammonium surfactants; nonionic surfactants, preferably alkyl ethoxylates, alkyl polyglucosides, and/or amine oxide surfactants; amphoteric surfactants, preferably selected from

betaines and/or polycarboxylates (for example polyglycinates); and zwitterionic surfactants.

Preferred detergent compositions also comprise oxygen bleaches selected from perborates, percarbonates, and mixtures thereof, more preferably in combination with bleach activators such as nonanoyloxybenzene sulfonate (NOBS) and tetraacetyl ethylene diamine (TAED) activators, and mixtures thereof. Preformed percarboxylic acid bleaching agents may also be used.

Preferred compositions according to the present invention are directed to granular detergent compositions comprising:

- a) from about 0.1% to about 50% by weight of a bleaching agent;
- b) from about 1% to about 80% by weight of a builder selected from the group consisting of aluminosilicates, silicates, and mixtures thereof;
- c) from about 0.0001% to about 2% by weight of active deterative enzyme selected from the group consisting of proteases, amylases, lipases, cellulases, and mixtures thereof;
- d) from about 0.0001% to about 5% (preferably from about 0.001% to about 2%) by weight of an isopeptidase enzyme; and
- e) from about 0.1% to about 99.8% by weight of detergent composition adjunct ingredients.

The present invention also relates to methods for laundering fabrics. This includes machine laundering processes comprising contacting in a laundry machine a fabric in need of cleaning with an aqueous solution comprising an isopeptidase active amount of an isopeptidase enzyme (and preferably also a deterative surfactant). Another laundering process is a hand washing method comprising soaking (preferably for at least about 5 minutes, more preferably for at least about 15 minutes) a fabric in need of cleaning in an aqueous solution comprising an isopeptidase active amount of an isopeptidase enzyme.

All percentages, ratios and proportions herein are by weight of ingredients used to prepare the finished compositions unless otherwise specified. All documents cited herein are, in relevant part, incorporated herein by reference.

DETAILED DESCRIPTION OF THE INVENTION

This invention provides detergent compositions which deliver effective cleaning of soils and stains (especially body soils and stains) via use of an isopeptidase enzyme as described herein, preferably in combination with one or more of a bleaching agent, aluminosilicate, silicate, deterative surfactant and/or deterative enzyme, preferably in granular form.

Preferred compositions are formulated with one or more deterative surfactants to assist in the cleaning process with the isopeptidase enzyme. Typical and preferred deterative surfactants are selected from anionic surfactants, preferably selected from the group of alkyl alkoxyated sulfates, alkyl sulfates, and/or linear alkyl benzenesulfonate surfactants; cationic surfactants, preferably selected from quaternary ammonium surfactants; and nonionic surfactants, preferably alkyl ethoxylates, alkyl polyglucosides, and/or amine oxide surfactants.

Percarbonate and perborate, which deliver peroxide bleach into the wash, are a cornerstone technology of modern, ultra-compact granular laundry detergent formulas. Peroxide bleach is very hydrophilic and, while it cannot match the bleaching effectiveness delivered by peracids (formed for example from peroxide interaction with TAED), it is effective at decoloration of pigments (e.g., in particulates or beverage stains) and also can help remove the color from the organic residues associated with body soils.

This invention also provides detergent compositions which deliver effective cleaning of soils and stains by means of bleach activators (including preformed peracids), preferably hydrophobic bleach activators, used in combination with an isopeptidase enzyme in the present compositions and methods.

This invention also provides compositions which deliver effective cleaning of soils and stains via use of bleach catalysts in the present invention compositions and methods. Bleach catalysts (characterized by the presence of at least one transition metal atom) interact with peroxide to form very powerful hydrophilic bleaches. These bleaches deliver strong benefits on colored hydrophilic stains and hydrophilic everyday soils (i.e., socks). The catalysts are typically used at extremely low levels in cleaning products. As disclosed herein, products containing isopeptidase enzyme and bleaching agents, with catalysts, deliver superior cleaning and/or whiteness performance. It is to be recognized, however, that historical use of bleach catalysts has been made difficult because of concerns about fabric damage (dimanganese catalysts are known to cause fabric damage), and thus such concerns must be considered when formulating compositions according to the present invention containing bleach catalysts.

This invention further provides compositions which deliver effective cleaning of soils and stains via use of builders selected from aluminosilicates, silicates, phosphates, carbonates, and mixtures thereof in the present invention compositions, preferably in granular form.

- In addition, the present invention provides compositions which deliver effective cleaning of soils and stains via use of additional detergent enzymes in the present invention compositions and methods.

Isopeptidase Enzymes:

An essential component of the cleaning compositions of the present invention is an isopeptidase enzyme. The term "isopeptidase enzyme", as used herein, means an enzyme having the ability to catalytically cleave the isopeptide bond between the glutamine gamma-carboxamide and lysine epsilon-amino group. Also for purposes of the present invention, the term "isopeptidase active amount" as used herein means a quantity of isopeptidase enzyme having the necessary level of catalytic activity to be effective for providing cleaning benefits under normal use conditions. The isopeptidase enzyme is preferably incorporated into the present invention compositions at a level of from about 0.0001% to about 5%, preferably from about 0.01% to about 2.

The catalytic activity of the isopeptidase enzyme will typically vary depending on the specific enzyme variant used. Individual isopeptidase enzyme catalytic activity may be determined by the method of Baskova, I. P., and Nikonov, G. I. (1991), Blood Coagulation and Fibrinolysis 2, 167-172, as follows: "Amidolytic activity of the test preparations was determined using chromogenic substrate L- γ -Glu-pNA (Behringwerke, Austria) at 405 nm according to the method described by Svendsen et al. [Svendsen L., Blomback B, Blomback M, et al. Synthetic chromogenic substrate for determination of trypsin, thrombin and thrombin-like enzymes. Thromb Res 1972; 1: 267-278.] Into a spectrophotometer cuvette was placed (0.9 - x) ml 0.05 M Tris-HCl buffer (pH 8.0); 0.2 ml substrate solution (0.45 mg/ml; 1.58×10^{-3} M in 0.05 M Tris-HCl buffer containing 0.01 M CaCl_2 , pH 8.0) and x ml of destabilase solution. Kinetics were determined by the Lineweaver and Burk method."

"Hydrolysis of isopeptide ϵ - (γ -Glu)-Lys by destabilase was determined in a system containing 32 nmol of isopeptide, 11.9 nmol of enzyme, 2.5 μl of H_2O and 80 μl of 0.05 M boric buffer, pH 7.4, at 36°C. 10 μl of 0.1 N HCl and 100 μl of 0.2 M citric buffer (pH 2.2) were divided into aliquots of 20 μl . Control samples contained saline instead of destabilase. 50 μl of the sample were put on to the amino acid analyser 'Biotronic LC 5001' analytic column (400 x 32 mm) with resin Biotronic BTC 2710, 7 - 8 mmk." [At page 168.]

Using these methods, the isopeptidase enzyme "destabilase" is reported (at page 169) to have the following properties: "specific activity of $0.15 \times 10^{-9} \text{ mol s}^{-1} \text{ mg}^{-1}$, $K_m = 2.2 \times 10^{-4} \text{ M}$, $k_{\text{kat}} = 3.53 \times 10^{-3} \text{ s}^{-1}$ (pH 8.0, 37°C)."

Isopeptidase enzymes herein include naturally derived isopeptidases such as "destabilase", whose amino acid sequence is known from the literature [Fradkov et al., "Enzyme from the medicinal leech (*Hirudo medicinalis*) that specifically splits

endo- ϵ (- γ -Glu)-Lys isopeptide bonds: cDNA cloning and protein primary structure", FEBS Letters, 390 (1996) 145-148; see SEQ ID Nos. 2 and 7], and any variants (e.g., SEQ ID Nos. 4 and 6) able to provide an isopeptidase active amount for purposes of cleaning compositions and methods according to the present invention. Such variants may be naturally occurring or genetically engineered. Preferred variants show a positive immunological cross-reaction with an antibody directed against naturally occurring isopeptidase enzyme.

Because the isopeptidase to be used in the present invention compositions and methods should be as inexpensive as possible, the enzyme will need to be economically produced in large amounts and thus is preferably engineered for expression in a transgenic expression system. These systems are known in the art of protein expression, and may include, but are not limited to, expression in gram negative bacteria such as Escherichia coli, gram positive bacteria such as Bacillus subtilis, yeast such as Saccharomyces cerevisiae or Pichia pastoris, fungi such as Aspergillus, mammalian or insect cell cultures, or in crops such as tobacco, corn, soybean or other plants which can be genetically altered to express and accumulate proteins. The cDNA nucleotides have been isolated and sequences determined for destabilase and two variants thereof (SEQ ID Nos. 1,3 and 5).

Any such variants may be specifically designed with regard to the optimization of performance efficiency in the detergent compositions and methods of the invention. For example, variants may be designed such that the compatibility of the enzyme to commonly encountered cleaning composition components is increased. Also the variant may be designed such that optimal pH, bleach stability, catalytic activity and the like of the enzyme variant is tailored to suit the particular detergent application.

Additional detergent components

The detergent compositions of the invention may also contain additional detergent components. The precise nature of these additional components, and levels of incorporation thereof will depend on the physical form of the composition, and the precise nature of the washing operation for which it is to be used.

The compositions of the invention preferably contain one or more additional detergent components selected from surfactants, bleaching agents, other enzymes, builders, alkalinity system, organic polymeric compounds, suds suppressers, soil suspension and anti-redeposition agents, and corrosion inhibitors.

- Detersive Surfactants:

The detergent compositions according to the present invention preferably further comprise surfactants, herein also referred to as co-surfactants, preferably selected from: anionic surfactants, preferably selected from the group of alkyl alkoxylated sulfates, alkyl sulfates, and/or linear alkyl benzenesulfonate surfactants; cationic surfactants, preferably selected from quaternary ammonium surfactants; nonionic surfactants, preferably alkyl ethoxylates, alkyl polyglucosides, and/or amine or amine oxide surfactants; amphoteric surfactants, preferably selected from betaines and/or polycarboxylates (e.g., polyglycinates); and zwitterionic surfactants.

A wide range of these co-surfactants can be used in the detergent compositions of the present invention. A typical listing of anionic, nonionic, ampholytic and zwitterionic classes, and species of these co-surfactants, is given in US Patent 3,664,961 issued to Norris on May 23, 1972. Amphoteric surfactants are also described in detail in "Amphoteric Surfactants, Second Edition", E.G. Lomax, Editor (published 1996, by Marcel Dekker, Inc.)

The laundry detergent compositions of the present invention typically comprise from about 0.1% to about 35%, preferably from about 0.5% to about 15%, by weight of co-surfactants. Selected surfactants are further identified as follows.

(1) Anionic Co-surfactants:

Nonlimiting examples of anionic co-surfactants useful herein, typically at levels from about 0.1% to about 50%, by weight, include the conventional C₁₁-C₁₈ alkyl benzene sulfonates ("LAS") and primary, branched-chain and random C₁₀-C₂₀ alkyl sulfates ("AS"), the C₁₀-C₁₈ secondary (2,3) alkyl sulfates of the formula $\text{CH}_3(\text{CH}_2)_x(\text{CHOSO}_3^-\text{M}^+)\text{CH}_3$ and $\text{CH}_3(\text{CH}_2)_y(\text{CHOSO}_3^-\text{M}^+)\text{CH}_2\text{CH}_3$ where x and (y + 1) are integers of at least about 7, preferably at least about 9, and M is a water-solubilizing cation, especially sodium. unsaturated sulfates such as oleyl sulfate, the C₁₀-C₁₈ alpha-sulfonated fatty acid esters, the C₁₀-C₁₈ sulfated alkyl polyglycosides, the C₁₀-C₁₈ alkyl alkoxy sulfates ("AE_xS"; especially EO 1-7 ethoxy sulfates), and C₁₀-C₁₈ alkyl alkoxy carboxylates (especially the EO 1-5 ethoxycarboxylates). The C₁₂-C₁₈ betaines and sulfobetaines ("sultaines"), C₁₀-C₁₈ amine oxides, and the like, can also be included in the overall compositions. C₁₀-C₂₀ conventional soaps may also be used. If high sudsing is desired, the branched-chain C₁₀-C₁₆ soaps may be used. Other conventional useful anionic co-surfactants are listed in standard texts.

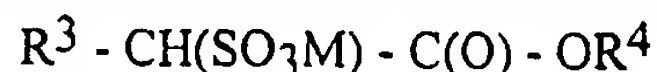
The alkyl alkoxylated sulfate surfactants useful herein are preferably water soluble salts or acids of the formula $\text{RO(A)}_m\text{SO}_3\text{M}$ wherein R is an unsubstituted C₁₀-C₂₄ alkyl or hydroxyalkyl group having a C₁₀-C₂₄ alkyl component,

preferably a C₁₂-C₁₈ alkyl or hydroxyalkyl, more preferably C₁₂-C₁₅ alkyl or hydroxyalkyl, A is an ethoxy or propoxy unit, m is greater than zero, typically between about 0.5 and about 6, more preferably between about 0.5 and about 3, and M is H or a cation which can be, for example, a metal cation (e.g., sodium, potassium, lithium, calcium, magnesium, etc.), ammonium or substituted-ammonium cation. Alkyl ethoxylated sulfates as well as alkyl propoxylated sulfates are contemplated herein. Specific examples of substituted ammonium cations include ethanol-, triethanol-, methyl-, dimethyl-, trimethyl-ammonium cations and quaternary ammonium cations such as tetramethyl-ammonium and dimethyl piperidinium cations and those derived from alkylamines such as ethylamine, diethylamine, triethylamine, mixtures thereof, and the like. Exemplary surfactants are C₁₂-C₁₅ alkyl polyethoxylate (1.0) sulfate (C₁₂-C₁₅E(1.0)M), C₁₂-C₁₅ alkyl polyethoxylate (2.25) sulfate (C₁₂-C₁₅E(2.25)M), C₁₂-C₁₅ alkyl polyethoxylate (3.0) sulfate (C₁₂-C₁₅E(3.0)M), and C₁₂-C₁₅ alkyl polyethoxylate (4.0) sulfate (C₁₂-C₁₅E(4.0)M), wherein M is conveniently selected from sodium and potassium.

The alkyl sulfate surfactants useful herein are preferably water soluble salts or acids of the formula ROSO₃M wherein R preferably is a C₁₀-C₂₄ hydrocarbyl, preferably an alkyl or hydroxyalkyl having a C₁₀-C₁₈ alkyl component, more preferably a C₁₂-C₁₅ alkyl or hydroxyalkyl, and M is H or a cation, e.g., an alkali metal cation (e.g. sodium, potassium, lithium), or ammonium or substituted ammonium (e.g. methyl-, dimethyl-, and trimethyl ammonium cations and quaternary ammonium cations such as tetramethyl-ammonium and dimethyl piperidinium cations and quaternary ammonium cations derived from alkylamines such as ethylamine, diethylamine, triethylamine, and mixtures thereof, and the like).

Other suitable anionic surfactants that can be used are alkyl ester sulfonate surfactants including linear esters of C₈-C₂₀ carboxylic acids (i.e., fatty acids) which are sulfonated with gaseous SO₃ according to "The Journal of the American Oil Chemists Society", 52 (1975), pp. 323-329. Suitable starting materials would include natural fatty substances as derived from tallow, palm oil, etc.

The preferred alkyl ester sulfonate surfactant, especially for laundry applications, comprise alkyl ester sulfonate surfactants of the structural formula :

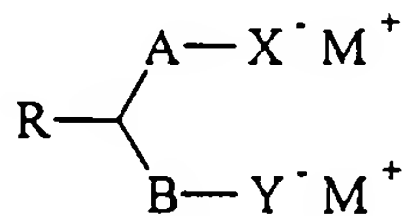


wherein R³ is a C₈-C₂₀ hydrocarbyl, preferably an alkyl, or combination thereof, R⁴ is a C₁-C₆ hydrocarbyl, preferably an alkyl, or combination thereof, and M is a cation which forms a water soluble salt with the alkyl ester sulfonate. Suitable salt-forming cations include metals such as sodium, potassium, and lithium, and substituted or unsubstituted ammonium cations, such as monoethanolamine,

diethanolamine, and triethanolamine. Preferably, R^3 is C_{10} - C_{16} alkyl, and R^4 is methyl, ethyl or isopropyl. Especially preferred are the methyl ester sulfonates wherein R^3 is C_{10} - C_{16} alkyl.

Other anionic co-surfactants useful for deterative purposes can also be included in the laundry detergent compositions of the present invention. These can include salts (including, for example, sodium, potassium, ammonium, and substituted ammonium salts such as mono-, di- and triethanolamine salts) of soap, C_8 - C_{22} primary or secondary alkanesulfonates, C_8 - C_{24} olefinsulfonates, sulfonated polycarboxylic acids prepared by sulfonation of the pyrolyzed product of alkaline earth metal citrates, e.g., as described in British patent specification No. 1,082,179, C_8 - C_{24} alkylpolyglycoethersulfates (containing up to 10 moles of ethylene oxide); alkyl glycerol sulfonates, fatty acyl glycerol sulfonates, fatty oleoyl glycerol sulfates, alkyl phenol ethylene oxide ether sulfates, paraffin sulfonates, alkyl phosphates, isethionates such as the acyl isethionates, N-acyl taurates, alkyl succinamates and sulfosuccinates, monoesters of sulfosuccinates (especially saturated and unsaturated C_{12} - C_{18} monoesters) and diesters of sulfosuccinates (especially saturated and unsaturated C_6 - C_{12} diesters), sulfates of alkylpolysaccharides such as the sulfates of alkylpolyglucoside (the nonionic nonsulfated compounds being described below), and alkyl polyethoxy carboxylates such as those of the formula $RO(CH_2CH_2O)_kCH_2COO-M^+$ wherein R is a C_8 - C_{22} alkyl, k is an integer from 0 to 10, and M is a soluble salt-forming cation. Resin acids and hydrogenated resin acids are also suitable, such as rosin, hydrogenated rosin, and resin acids and hydrogenated resin acids present in or derived from tall oil. Further examples are described in "Surface Active Agents and Detergents" (Vol. I and II by Schwartz, Perry and Berch). A variety of such surfactants are also generally disclosed in U.S. Patent 3,929,678, issued December 30, 1975 to Laughlin, et al. at Column 23, line 58 through Column 29, line 23 (herein incorporated by reference).

A preferred disulfate surfactant has the formula



where R is an alkyl, substituted alkyl, alkenyl, aryl, alkaryl, ether, ester, amine or amide group of chain length C_1 to C_{28} , preferably C_3 to C_{24} , most preferably C_8 to C_{20} , or hydrogen; A and B are independently selected from alkyl, substituted alkyl, and alkenyl groups of chain length C_1 to C_{28} , preferably C_1 to C_5 , most preferably

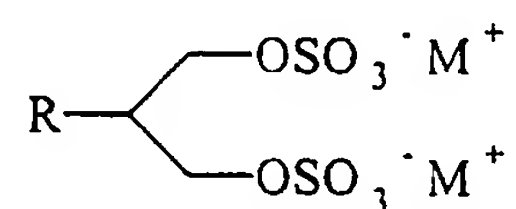
G_1 or C_2 , or a covalent bond, and A and B in total contain at least 2 atoms; A, B, and R in total contain from 4 to about 31 carbon atoms; X and Y are anionic groups selected from the group consisting of sulfate and sulfonate, provided that at least one of X or Y is a sulfate group; and M is a cationic moiety, preferably a substituted or unsubstituted ammonium ion, or an alkali or alkaline earth metal ion.

The most preferred disulfate surfactant has the formula as above where R is an alkyl group of chain length from C_{10} to C_{18} , A and B are independently C_1 or C_2 , both X and Y are sulfate groups, and M is a potassium, ammonium, or a sodium ion.

The disulfate surfactant is typically present at levels of incorporation of from about 0.1% to about 50%, preferably from about 0.1% to about 35%, most preferably from about 0.5% to about 15% by weight of the detergent composition.

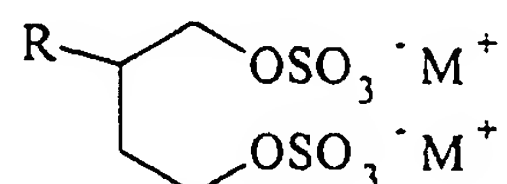
Preferred disulfate surfactant herein include:

(a) 1,3 disulfate compounds, preferably 1,3 C_7 - C_{23} (i.e., the total number of carbons in the molecule) straight or branched chain alkyl or alkenyl disulfates, more preferably having the formula:



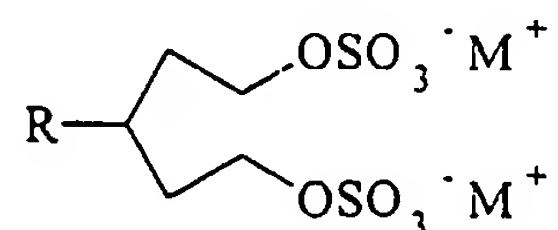
wherein R is a straight or branched chain alkyl or alkenyl group of chain length from about C_4 to about C_{18} ;

(b) 1,4 disulfate compounds, preferably 1,4 C_8 - C_{22} straight or branched chain alkyl or alkenyl disulfates, more preferably having the formula:



wherein R is a straight or branched chain alkyl or alkenyl group of chain length from about C_4 to about C_{18} ; preferred R are selected from octanyl, nonanyl, decyl, dodecyl, tetradecyl, hexadecyl, octadecyl, and mixtures thereof; and

(c) 1,5 disulfate compounds, preferably 1,5 C_9 - C_{23} straight or branched chain alkyl or alkenyl disulfates, more preferably having the formula:



wherein R is a straight or branched chain alkyl or alkenyl group of chain length from about C₄ to about C₁₈.

Known syntheses of certain disulfated surfactants, in general, use an alkyl or alkenyl succinic anhydride as the principal starting material. This is initially subjected to a reduction step from which a diol is obtained. Subsequently the diol is subjected to a sulfation step to give the disulfated product. As an example, US-A-3,634,269 describes 2-alkyl or alkenyl-1,4-butanediol disulfates prepared by the reduction of alkenyl succinic anhydrides with lithium aluminium hydride to produce either alkenyl or alkyl diols which are then sulfated. In addition, US-A-3,959,334 and US-A-4,000,081 describe 2-hydrocarbyl-1,4-butanediol disulfates also prepared using a method involving the reduction of alkenyl succinic anhydrides with lithium aluminium hydride to produce either alkenyl or alkyl diols which are then sulfated.

See also US-A-3,832,408 and US-A-3,860,625 which describe 2-alkyl or alkenyl-1,4-butanediol ethoxylate disulfates prepared by the reduction of alkenyl succinic anhydrides with lithium aluminium hydride to produce either alkenyl or alkyl diols which are then ethoxylated prior to sulfation.

These compounds may also be made by a method involving synthesis of the disulfate surfactant from a substituted cyclic anhydride having one or more carbon chain substituents having in total at least 5 carbon atoms comprising the following steps:

- (i) reduction of said substituted cyclic anhydride to form a diol; and
- (ii) sulfation of said diol to form a disulfate

wherein said reduction step comprises hydrogenation under pressure in the presence of a transition metal-containing hydrogenation catalyst.

When included therein, the laundry detergent compositions of the present invention typically comprise from about 0.1% to about 50%, preferably from about 1% to about 40% by weight of an anionic surfactant.

(2) Nonionic Co-surfactants:

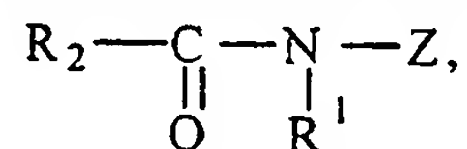
Nonlimiting examples of nonionic co-surfactants useful herein typically at levels from about 0.1% to about 50%, by weight include the alkoxylated alcohols (AE's) and alkyl phenols, polyhydroxy fatty acid amides (PFAA's), alkyl polyglycosides (APG's), C₁₀-C₁₈ glycerol ethers, and the like.

More specifically, the condensation products of primary and secondary aliphatic alcohols with from about 1 to about 25 moles of ethylene oxide (AE) are suitable for use as the nonionic surfactant in the present invention. The alkyl chain of the aliphatic alcohol can either be straight or branched, primary or secondary, and generally contains from about 8 to about 22 carbon atoms. Preferred are the

condensation products of alcohols having an alkyl group containing from about 8 to about 20 carbon atoms, more preferably from about 10 to about 18 carbon atoms, with from about 1 to about 10 moles, preferably 2 to 7, most preferably 2 to 5, of ethylene oxide per mole of alcohol. Especially preferred nonionic surfactants of this type are the C₉-C₁₅ primary alcohol ethoxylates containing 3-12 moles of ethylene oxide per mole of alcohol, particularly the C₁₂-C₁₅ primary alcohols containing 5-10 moles of ethylene oxide per mole of alcohol.

Examples of commercially available nonionic surfactants of this type include: TergitolTM 15-S-9 (the condensation product of C₁₁-C₁₅ linear alcohol with 9 moles ethylene oxide) and TergitolTM 24-L-6 NMW (the condensation product of C₁₂-C₁₄ primary alcohol with 6 moles ethylene oxide with a narrow molecular weight distribution), both marketed by Union Carbide Corporation; NeodolTM 45-9 (the condensation product of C₁₄-C₁₅ linear alcohol with 9 moles of ethylene oxide), NeodolTM 23-3 (the condensation product of C₁₂-C₁₃ linear alcohol with 3 moles of ethylene oxide), NeodolTM 45-7 (the condensation product of C₁₄-C₁₅ linear alcohol with 7 moles of ethylene oxide) and NeodolTM 45-5 (the condensation product of C₁₄-C₁₅ linear alcohol with 5 moles of ethylene oxide) marketed by Shell Chemical Company; KyroTM EOB (the condensation product of C₁₃-C₁₅ alcohol with 9 moles ethylene oxide), marketed by The Procter & Gamble Company; and Genapol LA O3O or O5O (the condensation product of C₁₂-C₁₄ alcohol with 3 or 5 moles of ethylene oxide) marketed by Hoechst. The preferred range of HLB in these AE nonionic surfactants is from 8-17 and most preferred from 8-14. Condensates with propylene oxide and butylene oxides may also be used.

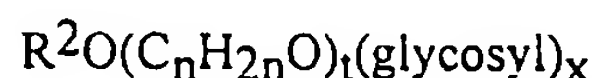
Another class of preferred nonionic co-surfactants for use herein are the polyhydroxy fatty acid amide surfactants of the formula.



wherein R¹ is H, or C₁₋₄ hydrocarbyl, 2-hydroxy ethyl, 2-hydroxy propyl or a mixture thereof, R² is C₅₋₃₁ hydrocarbyl, and Z is a polyhydroxyhydrocarbyl having a linear hydrocarbyl chain with at least 3 hydroxyls directly connected to the chain, or an alkoxylated derivative thereof. Preferably, R¹ is methyl, R² is a straight C₁₁₋₁₅ alkyl or C₁₅₋₁₇ alkyl or alkenyl chain such as coconut alkyl or mixtures thereof, and Z is derived from a reducing sugar such as glucose, fructose, maltose, lactose, in a reductive amination reaction. Typical examples include the C₁₂-C₁₈ and C₁₂-C₁₄ N-methylglucamides. See U.S. 5,194,639 and 5,298,636. N-alkoxy polyhydroxy fatty acid amides can also be used; see U.S. 5,489,393.

Also useful as a nonionic co-surfactant in the present invention are the alkylpolysaccharides such as those disclosed in U.S. Patent 4,565,647, Llenado, issued January 21, 1986, having a hydrophobic group containing from about 6 to about 30 carbon atoms, preferably from about 10 to about 16 carbon atoms, and a polysaccharide, e.g. a polyglycoside, hydrophilic group containing from about 1.3 to about 10, preferably from about 1.3 to about 3, most preferably from about 1.3 to about 2.7 saccharide units. Any reducing saccharide containing 5 or 6 carbon atoms can be used, e.g., glucose, galactose and galactosyl moieties can be substituted for the glucosyl moieties (optionally the hydrophobic group is attached at the 2-, 3-, 4-, etc. positions thus giving a glucose or galactose as opposed to a glucoside or galactoside). The intersaccharide bonds can be, e.g., between the one position of the additional saccharide units and the 2-, 3-, 4-, and/or 6- positions on the preceding saccharide units.

Preferred alkylpolyglycosides have the formula



wherein R^2 is selected from the group consisting of alkyl, alkylphenyl, hydroxyalkyl, hydroxyalkylphenyl, and mixtures thereof in which the alkyl groups contain from about 10 to about 18, preferably from about 12 to about 14, carbon atoms; n is 2 or 3, preferably 2; t is from 0 to about 10, preferably 0; and x is from about 1.3 to about 10, preferably from about 1.3 to about 3, most preferably from about 1.3 to about 2.7. The glycosyl is preferably derived from glucose. To prepare these compounds, the alcohol or alkylpolyethoxy alcohol is formed first and then reacted with glucose, or a source of glucose, to form the glucoside (attachment at the 1-position). The additional glycosyl units can then be attached between their 1-position and the preceding glycosyl units 2-, 3-, 4- and/or 6-position, preferably predominately the 2-position. Compounds of this type and their use in detergent are disclosed in EP-B 0 070 077, 0 075 996 and 0 094 118.

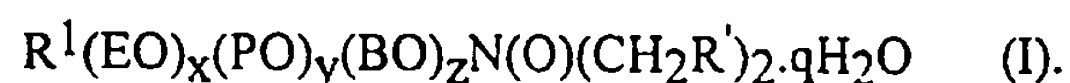
Polyethylene, polypropylene, and polybutylene oxide condensates of alkyl phenols are also suitable for use as the nonionic surfactant of the surfactant systems of the present invention, with the polyethylene oxide condensates being preferred. These compounds include the condensation products of alkyl phenols having an alkyl group containing from about 6 to about 14 carbon atoms, preferably from about 8 to about 14 carbon atoms, in either a straight-chain or branched-chain configuration with the alkylene oxide. In a preferred embodiment, the ethylene oxide is present in an amount equal to from about 2 to about 25 moles, more preferably

from about 3 to about 15 moles, of ethylene oxide per mole of alkyl phenol. Commercially available nonionic surfactants of this type include IgepalTM CO-630, marketed by the GAF Corporation; and TritonTM X-45, X-114, X-100 and X-102, all marketed by the Rohm & Haas Company. These surfactants are commonly referred to as alkylphenol alkoxylates (e.g., alkyl phenol ethoxylates).

The condensation products of ethylene oxide with a hydrophobic base formed by the condensation of propylene oxide with propylene glycol are also suitable for use as the additional nonionic surfactant in the present invention. The hydrophobic portion of these compounds will preferably have a molecular weight of from about 1500 to about 1800 and will exhibit water insolubility. The addition of polyoxyethylene moieties to this hydrophobic portion tends to increase the water solubility of the molecule as a whole, and the liquid character of the product is retained up to the point where the polyoxyethylene content is about 50% of the total weight of the condensation product, which corresponds to condensation with up to about 40 moles of ethylene oxide. Examples of compounds of this type include certain of the commercially-available PluronicTM surfactants, marketed by BASF.

Also suitable for use as the nonionic surfactant of the nonionic surfactant system of the present invention, are the condensation products of ethylene oxide with the product resulting from the reaction of propylene oxide and ethylenediamine. The hydrophobic moiety of these products consists of the reaction product of ethylenediamine and excess propylene oxide, and generally has a molecular weight of from about 2500 to about 3000. This hydrophobic moiety is condensed with ethylene oxide to the extent that the condensation product contains from about 40% to about 80% by weight of polyoxyethylene and has a molecular weight of from about 5,000 to about 11,000. Examples of this type of nonionic surfactant include certain of the commercially available TetronicTM compounds, marketed by BASF.

Also preferred nonionics are amine oxide surfactants. The compositions of the present invention may comprise amine oxide in accordance with the general formula I:



In general, it can be seen that the structure (I) provides one long-chain moiety $R^1(EO)_x(PO)_y(BO)_z$ and two short chain moieties, CH_2R' . R' is preferably selected from hydrogen, methyl and $-CH_2OH$. In general R^1 is a primary or branched hydrocarbyl moiety which can be saturated or unsaturated, preferably, R^1 is a primary alkyl moiety. When $x+y+z = 0$, R^1 is a hydrocarbyl moiety having

chainlength of from about 8 to about 18. When $x+y+z$ is different from 0, R^1 may be somewhat longer, having a chainlength in the range C_{12} - C_{24} . The general formula also encompasses amine oxides wherein $x+y+z = 0$, $R_1 = C_8$ - C_{18} , $R' = H$ and $q = 0$ -2, preferably 2. These amine oxides are illustrated by C_{12} - C_{14} alkyldimethyl amine oxide, hexadecyl dimethylamine oxide, octadecylamine oxide and their hydrates, especially the dihydrates as disclosed in U.S. Patents 5,075,501 and 5,071,594, incorporated herein by reference.

The invention also encompasses amine oxides wherein $x+y+z$ is different from zero, specifically $x+y+z$ is from about 1 to about 10, R^1 is a primary alkyl group containing 8 to about 24 carbons, preferably from about 12 to about 16 carbon atoms; in these embodiments $y + z$ is preferably 0 and x is preferably from about 1 to about 6, more preferably from about 2 to about 4; EO represents ethyleneoxy; PO represents propyleneoxy; and BO represents butyleneoxy. Such amine oxides can be prepared by conventional synthetic methods, e.g., by the reaction of alkylethoxysulfates with dimethylamine followed by oxidation of the ethoxylated amine with hydrogen peroxide.

Highly preferred amine oxides herein are solutions at ambient temperature. Amine oxides suitable for use herein are made commercially by a number of suppliers, including Akzo Chemie, Ethyl Corp., and Procter & Gamble. See McCutcheon's compilation and Kirk-Othmer review article for alternate amine oxide manufacturers.

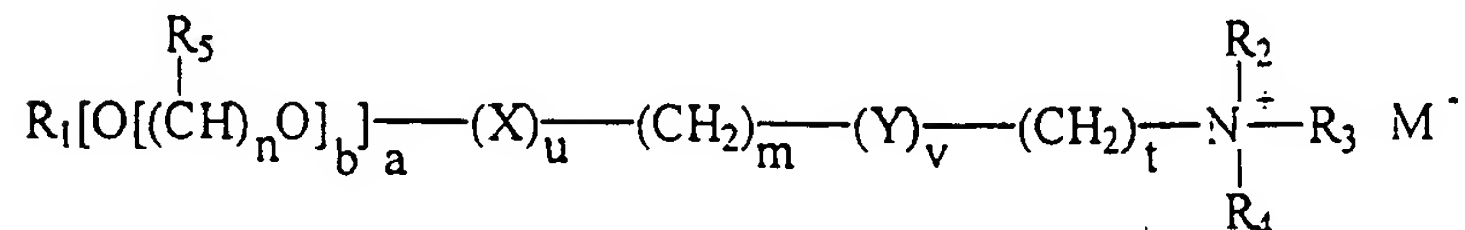
Whereas in certain of the preferred embodiments R' is H, there is some latitude with respect to having R' slightly larger than H. Specifically, the invention further encompasses embodiments wherein R' is CH_2OH , such as hexadecylbis(2-hydroxyethyl)amine oxide, tallowbis(2-hydroxyethyl)amine oxide, stearylbis(2-hydroxyethyl)amine oxide and oleylbis(2-hydroxyethyl)amine oxide, dodecyldimethylamine oxide dihydrate.

(3) Cationic Co-surfactants:

Nonlimiting examples of cationic co-surfactants useful herein typically at levels from about 0.1% to about 50%, by weight include the choline ester-type quats and alkoxylated quaternary ammonium (AQA) surfactant compounds, and the like.

Cationic co-surfactants useful as a component of the surfactant system is a cationic choline ester-type quat surfactant which are preferably water dispersible compounds having surfactant properties and comprise at least one ester (i.e. $-COO-$) linkage and at least one cationically charged group. Suitable cationic ester surfactants, including choline ester surfactants, have for example been disclosed in U.S. Patents Nos. 4,228,042, 4,239,660 and 4,260,529.

Preferred cationic ester surfactants are those having the formula:

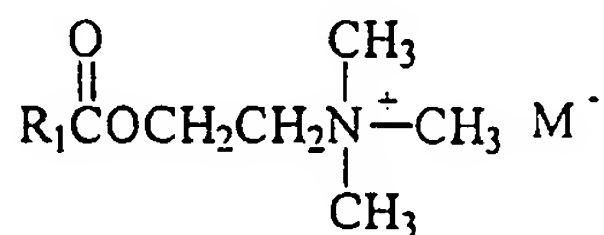


wherein R_1 is a C_5 - C_{31} linear or branched alkyl, alkenyl or alkaryl chain or M^- . $N^+(R_6R_7R_8)(CH_2)_5$; X and Y, independently, are selected from the group consisting of COO, OCO, O, CO, OCOO, CONH, NHCO, OCONH and NHCOO wherein at least one of X or Y is a COO, OCO, OCOO, OCONH or NHCOO group; R_2 , R_3 , R_4 , R_6 , R_7 and R_8 are independently selected from the group consisting of alkyl, alkenyl, hydroxyalkyl, hydroxyalkenyl and alkaryl groups having from 1 to 4 carbon atoms; and R_5 is independently H or a C_1 - C_3 alkyl group; wherein the values of m, n, s and t independently lie in the range of from 0 to 8, the value of b lies in the range from 0 to 20, and the values of a, u and v independently are either 0 or 1 with the proviso that at least one of u or v must be 1; and wherein M is a counter anion.

Preferably R_2 , R_3 and R_4 are independently selected from CH_3 and $-CH_2CH_2OH$.

Preferably M is selected from the group consisting of halide, methyl sulfate, sulfate, and nitrate, more preferably methyl sulfate, chloride, bromide or iodide.

Preferred water dispersible cationic ester surfactants are the choline esters having the formula:



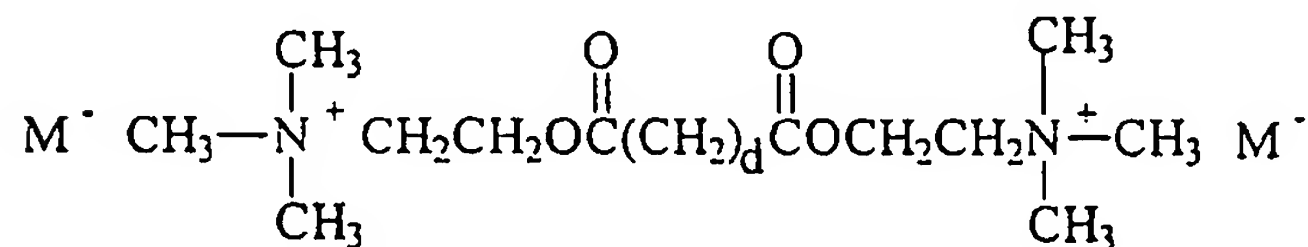
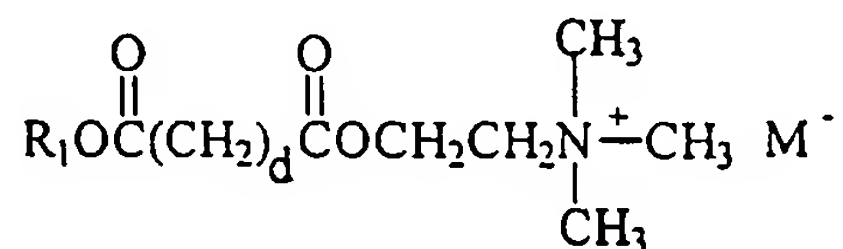
wherein R_1 is a C_{11} - C_{19} linear or branched alkyl chain.

Particularly preferred choline esters of this type include the stearyl choline ester quaternary methylammonium halides ($R^1=C_{17}$ alkyl), palmitoyl choline ester quaternary methylammonium halides ($R^1=C_{15}$ alkyl), myristoyl choline ester quaternary methylammonium halides ($R^1=C_{13}$ alkyl), lauroyl choline ester quaternary methylammonium halides ($R^1=C_{11}$ alkyl), cocoyl choline ester quaternary methylammonium halides ($R^1=C_{11}$ - C_{13} alkyl), tallowyl choline ester

quaternary methylammonium halides ($R^1 = C_{15}-C_{17}$ alkyl), and any mixtures thereof.

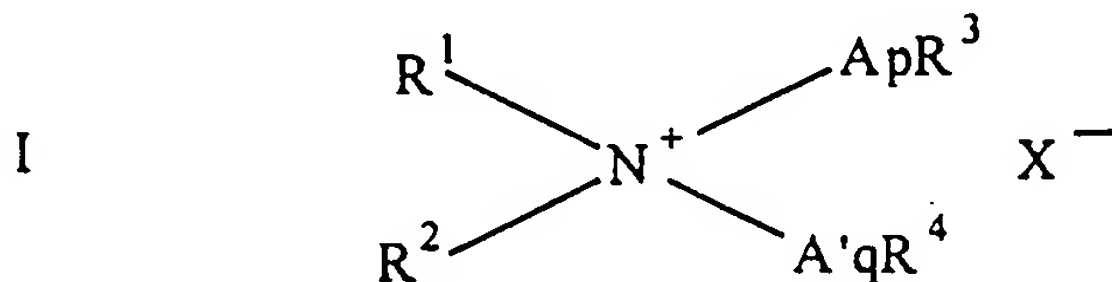
The particularly preferred choline esters, given above, may be prepared by the direct esterification of a fatty acid of the desired chain length with dimethylaminoethanol, in the presence of an acid catalyst. The reaction product is then quaternized with a methyl halide, preferably in the presence of a solvent such as ethanol, propylene glycol or preferably a fatty alcohol ethoxylate such as $C_{10}-C_{18}$ fatty alcohol ethoxylate having a degree of ethoxylation of from 3 to 50 ethoxy groups per mole forming the desired cationic material. They may also be prepared by the direct esterification of a long chain fatty acid of the desired chain length together with 2-haloethanol, in the presence of an acid catalyst material. The reaction product is then quaternized with trimethylamine, forming the desired cationic material.

Other suitable cationic ester surfactants have the structural formulas below, wherein d may be from 0 to 20.



In a preferred aspect these cationic ester surfactant are hydrolysable under the conditions of a laundry wash method.

Cationic co-surfactants useful herein also include alkoxyated quaternary ammonium (AQA) surfactant compounds (referred to hereinafter as "AQA compounds") having the formula:



wherein R^1 is an alkyl or alkenyl moiety containing from about 8 to about 18 carbon atoms, preferably 10 to about 16 carbon atoms, most preferably from about 10 to about 14 carbon atoms; R^2 is an alkyl group containing from one to three carbon atoms, preferably methyl; R^3 and R^4 can vary independently and are selected from hydrogen (preferred), methyl and ethyl; X^- is an anion such as chloride, bromide, methylsulfate, sulfate, or the like, sufficient to provide electrical neutrality. A and A' can vary independently and are each selected from C_1 - C_4 alkoxy, especially ethoxy (i.e., $-CH_2CH_2O-$), propoxy, butoxy and mixed ethoxy/propoxy; p is from 1 to about 30, preferably 1 to about 4 and q is from 1 to about 30, preferably 1 to about 4, and most preferably to about 4; preferably both p and q are 1. See also: EP 2,084, published May 30, 1979, by The Procter & Gamble Company, which describes cationic co-surfactants of this type which are also useful herein..

AQA compounds wherein the hydrocarbyl substituent R^1 is C_8 - C_{11} , especially C_{10} , enhance the rate of dissolution of laundry granules, especially under cold water conditions, as compared with the higher chain length materials. Accordingly, the C_8 - C_{11} AQA surfactants may be preferred by some formulators. The levels of the AQA surfactants used to prepare finished laundry detergent compositions can range from about 0.1% to about 5%, typically from about 0.45% to about 2.5%, by weight.

According to the foregoing, the following are nonlimiting, specific illustrations of AQA surfactants used herein. It is to be understood that the degree of alkoxylation noted herein for the AQA surfactants is reported as an average, following common practice for conventional ethoxylated nonionic surfactants. This is because the ethoxylation reactions typically yield mixtures of materials with differing degrees of ethoxylation. Thus, it is not uncommon to report total EO values other than as whole numbers, e.g., "EO2.5", "EO3.5", and the like.

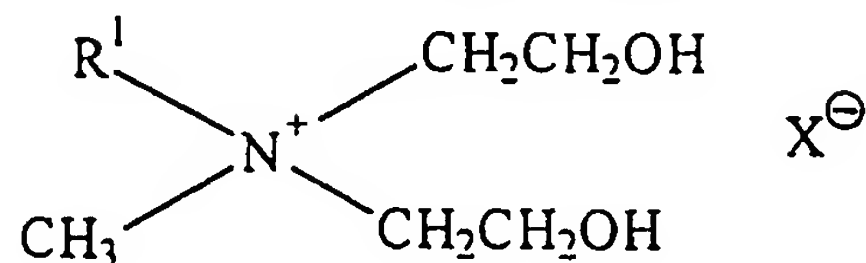
<u>Designation</u>	<u>R^1</u>	<u>R^2</u>	<u>ApR^3</u>	<u>$A'qR^4$</u>
AQA-1 (also referred to as Coco Methyl EO2)	C_{12} - C_{14}	CH_3	EO	EO
AQA-2	C_{12} - C_{16}	CH_3	(EO) ₂	EO
AQA-3 (Coco Methyl EO4)	C_{12} - C_{14}	CH_3	(EO) ₂	(EO) ₂
AQA-4	C_{12}	CH_3	EO	EO
AQA-5	C_{12} - C_{14}	CH_3	(EO) ₂	(EO) ₃

AQA-6	C ₁₂ -C ₁₄	CH ₃	(EO) ₂	(EO) ₃
AQA-7	C ₈ -C ₁₈	CH ₃	(EO) ₃	(EO) ₂
AQA-8	C ₁₂ -C ₁₄	CH ₃	(EO) ₄	(EO) ₄
AQA-9	C ₁₂ -C ₁₄	C ₂ H ₅	(EO) ₃	(EO) ₃
AQA-10	C ₁₂ -C ₁₈	C ₃ H ₇	(EO) ₃	(EO) ₄
AQA-11	C ₁₂ -C ₁₈	CH ₃	(propoxy)	(EO) ₃
AQA-12	C ₁₀ -C ₁₈	C ₂ H ₅	(iso-propoxy) ₂	(EO) ₃
AQA-13	C ₁₀ -C ₁₈	CH ₃	(EO/PO) ₂	(EO) ₃
AQA-14	C ₈ -C ₁₈	CH ₃	(EO) ₁₅ *	(EO) ₁₅ *
AQA-15	C ₁₀	CH ₃	EO	EO
AQA-16	C ₈ -C ₁₂	CH ₃	EO	EO
AQA-17	C ₉ -C ₁₁	CH ₃	- EO 3.5 Avg. -	
AQA-18	C ₁₂	CH ₃	- EO 3.5 Avg. -	
AQA-19	C ₈ -C ₁₄	CH ₃	(EO) ₁₀	(EO) ₁₀
AQA-20	C ₁₀	C ₂ H ₅	(EO) ₂	(EO) ₃
AQA-21	C ₁₂ -C ₁₄	C ₂ H ₅	(EO) ₅	(EO) ₃
AQA-22	C ₁₂ -C ₁₈	C ₃ H ₇	Bu	(EO) ₂

 *Ethoxy, optionally end-capped with methyl or ethyl.

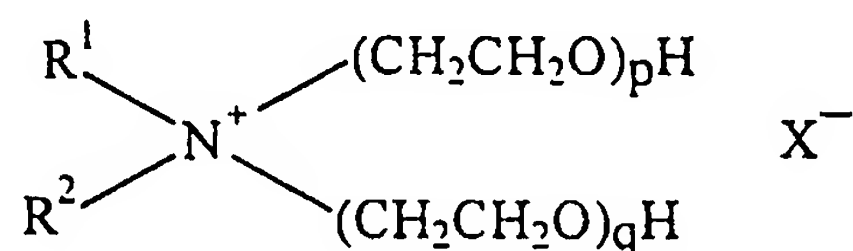
- The preferred bis-ethoxylated cationic surfactants herein are available under the trade name ETHOQUAD from Akzo Nobel Chemicals Company.

Highly preferred bis-AQA compounds for use herein are of the formula



wherein R^1 is C_{10} - C_{18} hydrocarbyl and mixtures thereof, preferably C_{10} , C_{12} , C_{14} alkyl and mixtures thereof, and X is any convenient anion to provide charge balance, preferably chloride. With reference to the general AQA structure noted above, since in a preferred compound R^1 is derived from coconut (C_{12} - C_{14} alkyl) fraction fatty acids, R^2 is methyl and ApR^3 and A'qR^4 are each monoethoxy, this preferred type of compound is referred to herein as "CocoMeEO2" or "AQA-1" in the above list.

Other preferred AQA compounds herein include compounds of the formula:



wherein R^1 is C_{10} - C_{18} hydrocarbyl, preferably C_{10} - C_{14} alkyl, independently p is 1 to about 3 and q is 1 to about 3, R^2 is C_1 - C_3 alkyl, preferably methyl, and X is an anion, especially chloride.

Other compounds of the foregoing type include those wherein the ethoxy ($\text{CH}_2\text{CH}_2\text{O}$) units (EO) are replaced by butoxy (Bu), isopropoxy [$\text{CH}(\text{CH}_3)\text{CH}_2\text{O}$] and [$\text{CH}_2\text{CH}(\text{CH}_3\text{O})$] units (i-Pr) or n-propoxy units (Pr), or mixtures of EO and/or Pr and/or i-Pr units.

The following illustrates various other adjunct ingredients which may be used in the compositions of this invention, but is not intended to be limiting thereof. While the combination of the isopeptidase enzymes with such adjunct compositional ingredients can be provided as finished products in the form of liquids, gels, bars, or the like using conventional techniques, the manufacture of the granular laundry detergents herein requires some special processing techniques in order to achieve optimal performance. Accordingly, the manufacture of laundry granules will be described hereinafter separately in the Granules Manufacture section (below), for the convenience of the formulator.

Bleaching Compounds - Bleaching Agents and Bleach Activators - The detergent compositions herein preferably further contain bleaching agents or bleaching compositions containing a bleaching agent and one or more bleach activators. Bleaching agents will typically be at levels of from about 1% to about 30%, more typically from about 5% to about 20%, of the detergent composition,

especially for fabric laundering. If present, the amount of bleach activators will typically be from about 0.1% to about 60%, more typically from about 0.5% to about 40% of the bleaching composition comprising the bleaching agent-plus-bleach activator.

The bleaching agents used herein can be any of the bleaching agents useful for detergent compositions in textile cleaning, hard surface cleaning, or other cleaning purposes that are now known or become known. These include oxygen bleaches as well as other bleaching agents. Perborate bleaches, e.g., sodium perborate (e.g., mono- or tetra-hydrate) can be used herein.

Another category of bleaching agent that can be used without restriction encompasses percarboxylic acid bleaching agents and salts thereof. Suitable examples of this class of agents include magnesium monoperoxyphthalate hexahydrate, the magnesium salt of metachloro perbenzoic acid, 4-nonylamino-4-oxoperoxybutyric acid and diperoxydodecanedioic acid. Such bleaching agents are disclosed in U.S. Patent 4,483,781, Hartman, issued November 20, 1984, U.S. Patent Application 740,446, Burns et al, filed June 3, 1985, European Patent Application 0,133,354, Banks et al, published February 20, 1985, and U.S. Patent 4,412,934, Chung et al, issued November 1, 1983. Highly preferred bleaching agents also include 6-nonylamino-6-oxoperoxy-caproic acid as described in U.S. Patent 4,634,551, issued January 6, 1987 to Burns et al.

Peroxygen bleaching agents can also be used. Suitable peroxygen bleaching compounds include sodium carbonate peroxyhydrate and equivalent "percarbonate" bleaches, sodium pyrophosphate peroxyhydrate, urea peroxyhydrate, and sodium peroxide. Persulfate bleach (e.g., OXONE, manufactured commercially by DuPont) can also be used.

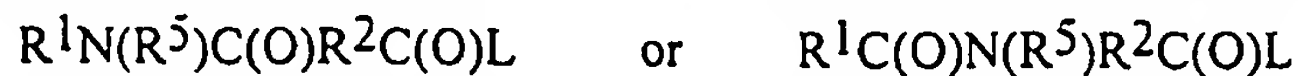
A preferred percarbonate bleach comprises dry particles having an average particle size in the range from about 500 micrometers to about 1,000 micrometers, not more than about 10% by weight of said particles being smaller than about 200 micrometers and not more than about 10% by weight of said particles being larger than about 1,250 micrometers. Optionally, the percarbonate can be coated with silicate, borate or water-soluble surfactants. Percarbonate is available from various commercial sources such as FMC, Solvay and Tokai Denka.

Mixtures of bleaching agents can also be used.

Peroxygen bleaching agents, the perborates, the percarbonates, etc., are preferably combined with bleach activators, which lead to the *in situ* production in aqueous solution (i.e., during the washing process) of the peroxy acid corresponding to the bleach activator. Various nonlimiting examples of activators are disclosed in

U.S. Patent 4,915,854, issued April 10, 1990 to Mao et al. and U.S. Patent 4,412,934. The nonanoyloxybenzene sulfonate (NOBS) and tetraacetyl ethylene diamine (TAED) activators are typical, and mixtures thereof can also be used. See also U.S. 4,634,551 for other typical bleaches and activators useful herein.

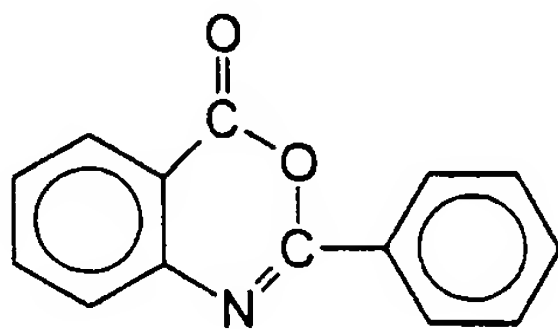
Highly preferred amido-derived bleach activators are those of the formulae:



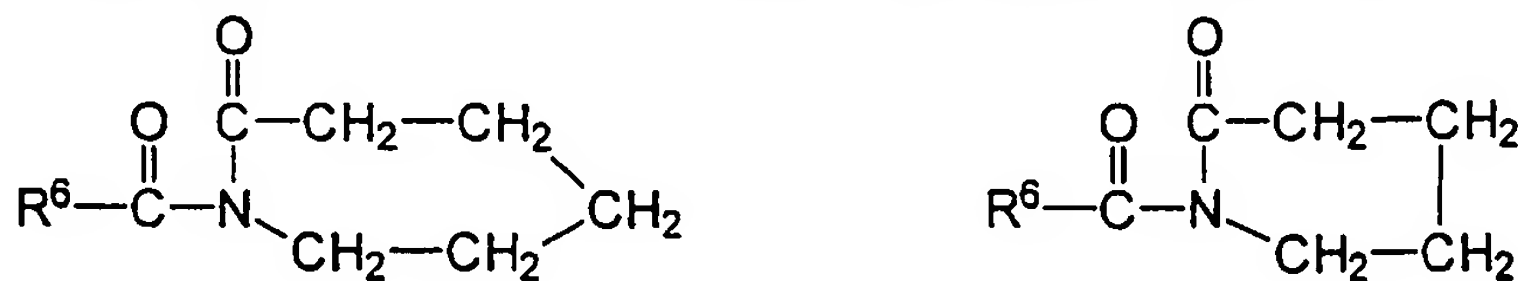
wherein R^1 is an alkyl group containing from about 6 to about 12 carbon atoms, R^2 is an alkylene containing from 1 to about 6 carbon atoms, R^5 is H or alkyl, aryl, or alkaryl containing from about 1 to about 10 carbon atoms, and L is any suitable leaving group. A leaving group is any group that is displaced from the bleach activator as a consequence of the nucleophilic attack on the bleach activator by the perhydrolysis anion. A preferred leaving group is phenyl sulfonate.

Preferred examples of bleach activators of the above formulae include (6-octanamido-caproyl)oxybenzenesulfonate, (6-nonanamidocaproyl)oxybenzenesulfonate, (6-decanamido-caproyl)oxybenzenesulfonate, and mixtures thereof as described in U.S. Patent 4,634,551, incorporated herein by reference.

Another class of bleach activators comprises the benzoxazin-type activators disclosed by Hodge et al in U.S. Patent 4,966,723, issued October 30, 1990, incorporated herein by reference. A highly preferred activator of the benzoxazin-type is:



Still another class of preferred bleach activators includes the acyl lactam activators, especially acyl caprolactams and acyl valerolactams of the formulae:



wherein R^6 is H or an alkyl, aryl, alkoxyaryl, or alkaryl group containing from 1 to about 12 carbon atoms. Highly preferred lactam activators include benzoyl caprolactam, octanoyl caprolactam, 3,5,5-trimethylhexanoyl caprolactam, nonanoyl caprolactam, decanoyl caprolactam, undecenoyl caprolactam, benzoyl valerolactam, octanoyl valerolactam, decanoyl valerolactam, undecenoyl valerolactam, nonanoyl valerolactam, 3,5,5-trimethylhexanoyl valerolactam and mixtures thereof. See also

U.S. Patent 4,545,784, issued to Sanderson, October 8, 1985, incorporated herein by reference, which discloses acyl caprolactams, including benzoyl caprolactam, adsorbed into sodium perborate.

Bleaching agents other than oxygen bleaching agents are also known in the art and can be utilized herein. One type of non-oxygen bleaching agent of particular interest includes photoactivated bleaching agents such as the sulfonated zinc and/or aluminum phthalocyanines. See U.S. Patent 4,033,718, issued July 5, 1977 to Holcombe et al. If used, detergent compositions will typically contain from about 0.025% to about 1.25%, by weight, of such bleaches, especially sulfonate zinc phthalocyanine.

If desired, the bleaching compounds can be catalyzed by means of a manganese compound. Such compounds are well known in the art and include, for example, the manganese-based catalysts disclosed in U.S. Pat. 5,246,621. U.S. Pat. 5,244,594; U.S. Pat. 5,194,416; U.S. Pat. 5,114,606; and European Pat. App. Pub. Nos. 549,271A1, 549,272A1, 544,440A2, and 544,490A1; Preferred examples of these catalysts include $\text{Mn}^{\text{IV}}_2(\text{u-O})_3(1,4,7\text{-trimethyl-}1,4,7\text{-triazacyclononane})_2(\text{PF}_6)_2$, $\text{Mn}^{\text{III}}_2(\text{u-O})_1(\text{u-OAc})_2(1,4,7\text{-trimethyl-}1,4,7\text{-triazacyclononane})_2(\text{ClO}_4)_2$, $\text{Mn}^{\text{IV}}_4(\text{u-O})_6(1,4,7\text{-triazacyclononane})_4(\text{ClO}_4)_4$, $\text{Mn}^{\text{III}}\text{Mn}^{\text{IV}}_4(\text{u-O})_1(\text{u-OAc})_2(1,4,7\text{-trimethyl-}1,4,7\text{-triazacyclononane})_2(\text{ClO}_4)_3$, $\text{Mn}^{\text{IV}}(1,4,7\text{-trimethyl-}1,4,7\text{-triazacyclononane})_3(\text{OCH}_3)_3(\text{PF}_6)$, and mixtures thereof. Other metal-based bleach catalysts include those disclosed in U.S. Pat. 4,430,243 and U.S. Pat. 5,114,611. The use of manganese with various complex ligands to enhance bleaching is also reported in the following United States Patents: 4,728,455; 5,284,944; 5,246,612; 5,256,779; 5,280,117; 5,274,147; 5,153,161; and 5,227,084.

As a practical matter, and not by way of limitation, the compositions and processes herein can be adjusted to provide on the order of at least one part per ten million of the active bleach catalyst species in the aqueous washing liquor, and will preferably provide from about 0.1 ppm to about 700 ppm, more preferably from about 1 ppm to about 500 ppm, of the catalyst species in the laundry liquor.

Cobalt bleach catalysts useful herein are known, and are described, for example, in M. L. Tobe, "Base Hydrolysis of Transition-Metal Complexes", Adv. Inorg. Bioinorg. Mech., (1983), 2, pages 1-94. The most preferred cobalt catalyst useful herein are cobalt pentaamine acetate salts having the formula $[\text{Co}(\text{NH}_3)_5\text{OAc}] \text{ T}_y$, wherein "OAc" represents an acetate moiety and "T_y" is an anion, and especially cobalt pentaamine acetate chloride, $[\text{Co}(\text{NH}_3)_5\text{OAc}]\text{Cl}_2$; as well as $[\text{Co}(\text{NH}_3)_5\text{OAc}](\text{OAc})_2$; $[\text{Co}(\text{NH}_3)_5\text{OAc}](\text{PF}_6)_2$; $[\text{Co}(\text{NH}_3)_5\text{OAc}](\text{SO}_4)$; $[\text{Co}(\text{NH}_3)_5\text{OAc}](\text{BF}_4)_2$; and $[\text{Co}(\text{NH}_3)_5\text{OAc}](\text{NO}_3)_2$ (herein "PAC").

- These cobalt catalysts are readily prepared by known procedures, such as taught for example in the Tobe article and the references cited therein, in U.S. Patent 4,810,410, to Diakun et al, issued March 7, 1989, J. Chem. Ed. (1989), 66 (12), 1043-45; The Synthesis and Characterization of Inorganic Compounds, W.L. Jolly (Prentice-Hall; 1970), pp. 461-3; Inorg. Chem., 18, 1497-1502 (1979); Inorg. Chem., 21, 2881-2885 (1982); Inorg. Chem., 18, 2023-2025 (1979); Inorg. Synthesis, 173-176 (1960); and Journal of Physical Chemistry, 56, 22-25 (1952).

As a practical matter, and not by way of limitation, the compositions and cleaning processes herein can be adjusted to provide on the order of at least one part per hundred million of the active bleach catalyst species in the aqueous washing medium, and will preferably provide from about 0.01 ppm to about 25 ppm, more preferably from about 0.05 ppm to about 10 ppm, and most preferably from about 0.1 ppm to about 5 ppm. of the bleach catalyst species in the wash liquor. In order to obtain such levels in the wash liquor of an automatic washing process, typical compositions herein will comprise from about 0.0005% to about 0.2%, more preferably from about 0.004% to about 0.08%, of bleach catalyst, especially manganese or cobalt catalysts, by weight of the cleaning compositions.

Enzymes - Enzymes are preferably included in the present detergent compositions for a variety of purposes, including removal of protein-based, carbohydrate-based, or triglyceride-based stains from substrates, for the prevention of refugee dye transfer in fabric laundering, and for fabric restoration. Suitable enzymes include proteases, amylases, lipases, cellulases, peroxidases, and mixtures thereof of any suitable origin, such as vegetable, animal, bacterial, fungal and yeast origin. Preferred selections are influenced by factors such as pH-activity and/or stability optima, thermostability, and stability to active detergents, builders and the like. In this respect bacterial or fungal enzymes are preferred, such as bacterial amylases and proteases, and fungal cellulases.

"Detersive enzyme", as used herein, means any enzyme having a cleaning, stain removing or otherwise beneficial effect in a laundry, hard surface cleaning or personal care detergent composition. Preferred detersive enzymes are hydrolases such as proteases, amylases and lipases. Preferred enzymes for laundry purposes include, but are not limited to, proteases, cellulases, lipases and peroxidases. Highly preferred for automatic dishwashing are amylases and/or proteases, including both current commercially available types and improved types which, though more and more bleach compatible though successive improvements, have a remaining degree of bleach deactivation susceptibility.

- Enzymes are normally incorporated into detergent or detergent additive compositions at levels sufficient to provide a "cleaning-effective amount". The term "cleaning effective amount" refers to any amount capable of producing a cleaning, stain removal, soil removal, whitening, deodorizing, or freshness improving effect on substrates such as fabrics, dishware and the like. In practical terms for current commercial preparations, typical amounts are up to about 5 mg by weight, more typically 0.01 mg to 3 mg, of active enzyme per gram of the detergent composition. Stated otherwise, the compositions herein will typically comprise from 0.001% to 5%, preferably 0.01%-1% by weight of a commercial enzyme preparation. Protease enzymes are usually present in such commercial preparations at levels sufficient to provide from 0.005 to 0.1 Anson units (AU) of activity per gram of composition. For certain detergents, such as in automatic dishwashing, it may be desirable to increase the active enzyme content of the commercial preparation in order to minimize the total amount of non-catalytically active materials and thereby improve spotting/filming or other end-results. Higher active levels may also be desirable in highly concentrated detergent formulations.

Suitable examples of proteases are the subtilisins which are obtained from particular strains of *B. subtilis* and *B. licheniformis*. One suitable protease is obtained from a strain of *Bacillus*, having maximum activity throughout the pH range of 8-12, developed and sold as ESPERASE® by Novo Industries A/S of Denmark, hereinafter "Novo". The preparation of this enzyme and analogous enzymes is described in GB 1,243,784 to Novo. Other suitable proteases include ALCALASE® and SAVINASE® from Novo and MAXATASE® from International Bio-Synthetics, Inc., The Netherlands; as well as Protease A as disclosed in EP 130,756 A, January 9, 1985 and Protease B as disclosed in EP 303,761 A, April 28, 1987 and EP 130,756 A, January 9, 1985. See also a high pH protease from *Bacillus* sp. NCIMB 40338 described in WO 9318140 A to Novo. Enzymatic detergents comprising protease, one or more other enzymes, and a reversible protease inhibitor are described in WO 9203529 A to Novo. Other preferred proteases include those of WO 9510591 A to Procter & Gamble. When desired, a protease having decreased adsorption and increased hydrolysis is available as described in WO 9507791 to Procter & Gamble. A recombinant trypsin-like protease for detergents suitable herein is described in WO 9425583 to Novo.

In more detail, an especially preferred protease, referred to as "Protease D" is a carbonyl hydrolase variant having an amino acid sequence not found in nature, which is derived from a precursor carbonyl hydrolase by substituting a different amino acid for a plurality of amino acid residues at a position in said carbonyl

hydrolase equivalent to position +76, preferably also in combination with one or more amino acid residue positions equivalent to those selected from the group consisting of +99, +101, +103, +104, +107, +123, +27, +105, +109, +126, +128, +135, +156, +166, +195, +197, +204, +206, +210, +216, +217, +218, +222, +260, +265, and/or +274 according to the numbering of *Bacillus amyloliquefaciens* subtilisin, as described in WO 95/10615 published April 20, 1995 by Genencor International.

Useful proteases are also described in PCT publications: WO 95/30010 published November 9, 1995 by The Procter & Gamble Company; WO 95/30011 published November 9, 1995 by The Procter & Gamble Company; WO 95/29979 published November 9, 1995 by The Procter & Gamble Company.

Amylases suitable herein, especially for, but not limited to automatic dishwashing purposes, include, for example, α -amylases described in GB 1,296,839 to Novo; RAPIDASE®, International Bio-Synthetics, Inc. and TERMAMYL®, Novo. FUNGAMYL® from Novo is especially useful. Engineering of enzymes for improved stability, e.g., oxidative stability, is known. See, for example J. Biological Chem., Vol. 260, No. 11, June 1985, pp. 6518-6521. Certain preferred embodiments of the present compositions can make use of amylases having improved stability in detergents such as automatic dishwashing types, especially improved oxidative stability as measured against a reference-point of TERMAMYL® in commercial use in 1993. These preferred amylases herein share the characteristic of being "stability-enhanced" amylases, characterized, at a minimum, by a measurable improvement in one or more of: oxidative stability, e.g., to hydrogen peroxide/tetraacetylenediamine in buffered solution at pH 9-10; thermal stability, e.g., at common wash temperatures such as about 60°C; or alkaline stability, e.g., at a pH from about 8 to about 11, measured versus the above-identified reference-point amylase. Stability can be measured using any of the art-disclosed technical tests. See, for example, references disclosed in WO 9402597. Stability-enhanced amylases can be obtained from Novo or from Genencor International. One class of highly preferred amylases herein have the commonality of being derived using site-directed mutagenesis from one or more of the *Bacillus* amylases, especially the *Bacillus* α -amylases, regardless of whether one, two or multiple amylase strains are the immediate precursors. Oxidative stability-enhanced amylases vs. the above-identified reference amylase are preferred for use, especially in bleaching, more preferably oxygen bleaching, as distinct from chlorine bleaching, detergent compositions herein. Such preferred amylases include (a) an amylase according to the hereinbefore incorporated WO 9402597, Novo, Feb. 3, 1994, as

further illustrated by a mutant in which substitution is made, using alanine or threonine, preferably threonine, of the methionine residue located in position 197 of the *B. licheniformis* alpha-amylase, known as TERMAMYL®, or the homologous position variation of a similar parent amylase, such as *B. amyloliquefaciens*, *B. subtilis*, or *B. stearothermophilus*; (b) stability-enhanced amylases as described by Genencor International in a paper entitled "Oxidatively Resistant alpha-Amylases" presented at the 207th American Chemical Society National Meeting, March 13-17 1994, by C. Mitchinson. Therein it was noted that bleaches in automatic dishwashing detergents inactivate alpha-amylases but that improved oxidative stability amylases have been made by Genencor from *B. licheniformis* NCIB8061. Methionine (Met) was identified as the most likely residue to be modified. Met was substituted, one at a time, in positions 8, 15, 197, 256, 304, 366 and 438 leading to specific mutants, particularly important being M197L and M197T with the M197T variant being the most stable expressed variant. Stability was measured in CASCADE® and SUNLIGHT®; (c) particularly preferred amylases herein include amylase variants having additional modification in the immediate parent as described in WO 9510603 A and are available from the assignee, Novo, as DURAMYL®. Other particularly preferred oxidative stability enhanced amylase include those described in WO 9418314 to Genencor International and WO 9402597 to Novo. Any other oxidative stability-enhanced amylase can be used, for example as derived by site-directed mutagenesis from known chimeric, hybrid or simple mutant parent forms of available amylases. Other preferred enzyme modifications are accessible. See WO 9509909 A to Novo.

Other amylase enzymes include those described in WO 95/26397 and in co-pending application by Novo Nordisk PCT/DK96/00056. Specific amylase enzymes for use in the detergent compositions of the present invention include α -amylases characterized by having a specific activity at least 25% higher than the specific activity of Termamyl® at a temperature range of 25°C to 55°C and at a pH value in the range of 8 to 10, measured by the Phadebas® α -amylase activity assay. (Such Phadebas® α -amylase activity assay is described at pages 9-10, WO 95/26397.) Also included herein are α -amylases which are at least 80% homologous with the amino acid sequences shown in the SEQ ID listings in the references. These enzymes are preferably incorporated into laundry detergent compositions at a level from 0.00018% to 0.060% pure enzyme by weight of the total composition, more preferably from 0.00024% to 0.048% pure enzyme by weight of the total composition.

- Cellulases usable herein include both bacterial and fungal types, preferably having a pH optimum between 5 and 9.5. U.S. 4,435,307, Barbesgoard et al, March 6, 1984, discloses suitable fungal cellulases from *Humicola insolens* or *Humicola* strain DSM1800 or a cellulase 212-producing fungus belonging to the genus *Aeromonas*, and cellulase extracted from the hepatopancreas of a marine mollusk, *Dolabella Auricula Solander*. Suitable cellulases are also disclosed in GB-A-2.075.028; GB-A-2.095.275 and DE-OS-2.247.832. CAREZYME® and CELLUZYME®(Novo) are especially useful. See also WO 9117243 to Novo.

Suitable lipase enzymes for detergent usage include those produced by microorganisms of the *Pseudomonas* group, such as *Pseudomonas stutzeri* ATCC 19.154, as disclosed in GB 1,372,034. See also lipases in Japanese Patent Application 53,20487, laid open Feb. 24, 1978. This lipase is available from Amano Pharmaceutical Co. Ltd., Nagoya, Japan, under the trade name Lipase P "Amano," or "Amano-P." Other suitable commercial lipases include Amano-CES, lipases ex *Chromobacter viscosum*, e.g. *Chromobacter viscosum* var. *lipolyticum* NRRLB 3673 from Toyo Jozo Co., Tagata, Japan; *Chromobacter viscosum* lipases from U.S. Biochemical Corp., U.S.A. and Disoynth Co., The Netherlands, and lipases ex *Pseudomonas gladioli*. LIPOLASE® enzyme derived from *Humicola lanuginosa* and commercially available from Novo, see also EP 341,947, is a preferred lipase for use herein. Lipase and amylase variants stabilized against peroxidase enzymes are described in WO 9414951 A to Novo. See also WO 9205249 and RD 94359044.

In spite of the large number of publications on lipase enzymes, only the lipase derived from *Humicola lanuginosa* and produced in *Aspergillus oryzae* as host has so far found widespread application as additive for fabric washing products. It is available from Novo Nordisk under the tradename Lipolase™, as noted above. In order to optimize the stain removal performance of Lipolase, Novo Nordisk have made a number of variants. As described in WO 92/05249, the D96L variant of the native *Humicola lanuginosa* lipase improves the lard stain removal efficiency by a factor 4.4 over the wild-type lipase (enzymes compared in an amount ranging from 0.075 to 2.5 mg protein per liter). Research Disclosure No. 35944 published on March 10, 1994, by Novo Nordisk discloses that the lipase variant (D96L) may be added in an amount corresponding to 0.001-100- mg (5-500,000 LU/liter) lipase variant per liter of wash liquor. The present invention provides the benefit of improved whiteness maintenance on fabrics using low levels of D96L variant in detergent compositions containing the isopeptidase enzymes in the manner disclosed

herein, especially when the D96L is used at levels in the range of about 50 LU to about 8500 LU per liter of wash solution.

Cutinase enzymes suitable for use herein are described in WO 8809357 A to Genencor.

Peroxidase enzymes may be used in combination with oxygen sources, e.g., percarbonate, perborate, hydrogen peroxide, etc., for "solution bleaching" or prevention of transfer of dyes or pigments removed from substrates during the wash to other substrates present in the wash solution. Known peroxidases include horseradish peroxidase, ligninase, and haloperoxidases such as chloro- or bromoperoxidase. Peroxidase-containing detergent compositions are disclosed in WO 89099813 A, October 19, 1989 to Novo and WO 8909813 A to Novo.

A range of enzyme materials and means for their incorporation into synthetic detergent compositions is also disclosed in WO 9307263 A and WO 9307260 A to Genencor International. WO 8908694 A to Novo, and U.S. 3,553,139, January 5, 1971 to McCarty et al. Enzymes are further disclosed in U.S. 4,101,457, Place et al, July 18, 1978, and in U.S. 4,507,219, Hughes. March 26, 1985. Enzyme materials useful for liquid detergent formulations, and their incorporation into such formulations, are disclosed in U.S. 4,261,868, Hora et al, April 14, 1981. Enzymes for use in detergents can be stabilised by various techniques. Enzyme stabilisation techniques are disclosed and exemplified in U.S. 3,600,319, August 17, 1971, Gedge et al, EP 199,405 and EP 200,586, October 29, 1986, Venegas. Enzyme stabilisation systems are also described, for example, in U.S. 3,519,570. A useful *Bacillus*, sp. AC13 giving proteases, xylanases and cellulases, is described in WO 9401532 A to Novo.

Enzyme Stabilizing System - The enzyme-containing compositions herein may optionally also comprise from about 0.001% to about 10%, preferably from about 0.005% to about 8%, most preferably from about 0.01% to about 6%, by weight of an enzyme stabilizing system. The enzyme stabilizing system can be any stabilizing system which is compatible with the deterative enzyme. Such a system may be inherently provided by other formulation actives, or be added separately, e.g., by the formulator or by a manufacturer of detergent-ready enzymes. Such stabilizing systems can, for example, comprise calcium ion, boric acid, propylene glycol, short chain carboxylic acids, boronic acids, and mixtures thereof, and are designed to address different stabilization problems depending on the type and physical form of the detergent composition.

One stabilizing approach is the use of water-soluble sources of calcium and/or magnesium ions in the finished compositions which provide such ions to the

enzymes. Calcium ions are generally more effective than magnesium ions and are preferred herein if only one type of cation is being used. Typical detergent compositions, especially liquids, will comprise from about 1 to about 30, preferably from about 2 to about 20, more preferably from about 8 to about 12 millimoles of calcium ion per liter of finished detergent composition, though variation is possible depending on factors including the multiplicity, type and levels of enzymes incorporated. Preferably water-soluble calcium or magnesium salts are employed, including for example calcium chloride, calcium hydroxide, calcium formate, calcium malate, calcium maleate, calcium hydroxide and calcium acetate; more generally, calcium sulfate or magnesium salts corresponding to the exemplified calcium salts may be used. Further increased levels of Calcium and/or Magnesium may of course be useful, for example for promoting the grease-cutting action of certain types of surfactant.

Another stabilizing approach is by use of borate species. See Severson, U.S. 4,537,706. Borate stabilizers, when used, may be at levels of up to 10% or more of the composition though more typically, levels of up to about 3% by weight of boric acid or other borate compounds such as borax or orthoborate are suitable for liquid detergent use. Substituted boric acids such as phenylboronic acid, butaneboronic acid, p-bromophenylboronic acid or the like can be used in place of boric acid and reduced levels of total boron in detergent compositions may be possible though the use of such substituted boron derivatives.

Stabilizing systems of certain cleaning compositions, for example automatic dishwashing compositions, may further comprise from 0 to about 10%, preferably from about 0.01% to about 6% by weight, of chlorine bleach scavengers, added to prevent chlorine bleach species present in many water supplies from attacking and inactivating the enzymes, especially under alkaline conditions. While chlorine levels in water may be small, typically in the range from about 0.5 ppm to about 1.75 ppm, the available chlorine in the total volume of water that comes in contact with the enzyme, for example during dish- or fabric-washing, can be relatively large; accordingly, enzyme stability to chlorine in-use is sometimes problematic. Since perborate or percarbonate, which have the ability to react with chlorine bleach, may present in certain of the instant compositions in amounts accounted for separately from the stabilizing system, the use of additional stabilizers against chlorine, may, most generally, not be essential, though improved results may be obtainable from their use. Suitable chlorine scavenger anions are widely known and readily available, and, if used, can be salts containing ammonium cations with sulfite, bisulfite, thiosulfite, thiosulfate, iodide, etc. Antioxidants such as carbamate,

ascorbate, etc., organic amines such as ethylenediaminetetracetic acid (EDTA) or alkali metal salt thereof, monoethanolamine (MEA), and mixtures thereof can likewise be used. Likewise, special enzyme inhibition systems can be incorporated such that different enzymes have maximum compatibility. Other conventional scavengers such as bisulfate, nitrate, chloride, sources of hydrogen peroxide such as sodium perborate tetrahydrate, sodium perborate monohydrate and sodium percarbonate, as well as phosphate, condensed phosphate, acetate, benzoate, citrate, formate, lactate, malate, tartrate, salicylate, etc., and mixtures thereof can be used if desired. In general, since the chlorine scavenger function can be performed by ingredients separately listed under better recognized functions, (e.g., hydrogen peroxide sources), there is no absolute requirement to add a separate chlorine scavenger unless a compound performing that function to the desired extent is absent from an enzyme-containing embodiment of the invention; even then, the scavenger is added only for optimum results. Moreover, the formulator will exercise a chemist's normal skill in avoiding the use of any enzyme scavenger or stabilizer which is majorly incompatible, as formulated, with other reactive ingredients. In relation to the use of ammonium salts, such salts can be simply admixed with the detergent composition but are prone to adsorb water and/or liberate ammonia during storage. Accordingly, such materials, if present, are desirably protected in a particle such as that described in US 4,652,392, Baginski et al.

Builders - Preferred builders for use in the present invention compositions, especially in granular form, are detergent builders selected from aluminosilicates and silicates are preferably included in the compositions herein, for example to assist in controlling mineral, especially Ca and/or Mg, hardness in wash water or to assist in the removal of particulate soils from surfaces.

Suitable silicate builders include water-soluble and hydrous solid types and including those having chain-, layer-, or three-dimensional- structure as well as amorphous-solid or non-structured-liquid types. Preferred are alkali metal silicates, particularly those liquids and solids having a $\text{SiO}_2:\text{Na}_2\text{O}$ ratio in the range 1.6:1 to 3.2:1, including, particularly for automatic dishwashing purposes, solid hydrous 2-ratio silicates marketed by PQ Corp. under the tradename BRITESIL®, e.g., BRITESIL H₂O; and layered silicates, e.g., those described in U.S. 4,664,839, May 12, 1987, H. P. Rieck. NaSKS-6, sometimes abbreviated "SKS-6", is a crystalline layered aluminium-free $\delta\text{-Na}_2\text{SiO}_5$ morphology silicate marketed by Hoechst and is preferred especially in granular laundry compositions. See preparative methods in German DE-A-3,417,649 and DE-A-3,742,043. Other layered silicates, such as those having the general formula $\text{NaMSi}_x\text{O}_{2x+1}\cdot y\text{H}_2\text{O}$ wherein M is sodium or

hydrogen, x is a number from 1.9 to 4, preferably 2, and y is a number from 0 to 20, preferably 0, can also or alternately be used herein. Layered silicates from Hoechst also include NaSKS-5, NaSKS-7 and NaSKS-11, as the α , β and γ layer-silicate forms. Other silicates may also be useful, such as magnesium silicate, which can serve as a crispening agent in granules, as a stabilising agent for bleaches, and as a component of suds control systems.

Also suitable for use herein are synthesized crystalline ion exchange materials or hydrates thereof having chain structure and a composition represented by the following general formula in an anhydride form: $xM_2O \cdot ySiO_2 \cdot zM'O$ wherein M is Na and/or K, M' is Ca and/or Mg; y/x is 0.5 to 2.0 and z/x is 0.005 to 1.0 as taught in U.S. 5,427,711, Sakaguchi et al, June 27, 1995.

Aluminosilicate builders are especially useful in granular detergents, but can also be incorporated in liquids, pastes or gels. Suitable for the present purposes are those having empirical formula: $[M_z(AlO_2)_z(SiO_2)_v] \cdot xH_2O$ wherein z and v are integers of at least 6, the molar ratio of z to v is in the range from 1.0 to 0.5, and x is an integer from 15 to 264. Aluminosilicates can be crystalline or amorphous, naturally-occurring or synthetically derived. An aluminosilicate production method is in U.S. 3,985,669, Krummel, et al, October 12, 1976. Preferred synthetic crystalline aluminosilicate ion exchange materials are available as Zeolite A, Zeolite P (B), Zeolite X and, to whatever extent this differs from Zeolite P, the so-called Zeolite MAP. Natural types, including clinoptilolite, may be used. Zeolite A has the formula: $Na_{12}[(AlO_2)_{12}(SiO_2)_{12}] \cdot xH_2O$ wherein x is from 20 to 30, especially 27. Dehydrated zeolites ($x = 0 - 10$) may also be used. Preferably, the aluminosilicate has a particle size of 0.1-10 microns in diameter.

Detergent builders in place of or in addition to the silicates and aluminosilicates described hereinbefore can optionally be included in the compositions herein, for example to assist in controlling mineral, especially Ca and/or Mg, hardness in wash water or to assist in the removal of particulate soils from surfaces. Builders can operate via a variety of mechanisms including forming soluble or insoluble complexes with hardness ions, by ion exchange, and by offering a surface more favorable to the precipitation of hardness ions than are the surfaces of articles to be cleaned. Builder level can vary widely depending upon end use and physical form of the composition. Built detergents typically comprise at least about 1% builder. Liquid formulations typically comprise about 5% to about 50%, more typically 5% to 35% of builder. Granular formulations typically comprise from about 10% to about 80%, more typically 15% to 50% builder by weight of the

detergent composition. Lower or higher levels of builders are not excluded. For example, certain detergent additive or high-surfactant formulations can be unbuilt.

Suitable builders herein can be selected from the group consisting of phosphates and polyphosphates, especially the sodium salts; carbonates, bicarbonates, sesquicarbonates and carbonate minerals other than sodium carbonate or sesquicarbonate; organic mono-, di-, tri-, and tetracarboxylates especially water-soluble nonsurfactant carboxylates in acid, sodium, potassium or alkanolammonium salt form, as well as oligomeric or water-soluble low molecular weight polymer carboxylates including aliphatic and aromatic types; and phytic acid. These may be complemented by borates, e.g., for pH-buffering purposes, or by sulfates, especially sodium sulfate and any other fillers or carriers which may be important to the engineering of stable surfactant and/or builder-containing detergent compositions.

Builder mixtures, sometimes termed "builder systems" can be used and typically comprise two or more conventional builders, optionally complemented by chelants, pH-buffers or fillers, though these latter materials are generally accounted for separately when describing quantities of materials herein. In terms of relative quantities of surfactant and builder in the present detergents, preferred builder systems are typically formulated at a weight ratio of surfactant to builder of from about 60:1 to about 1:80. Certain preferred laundry detergents have said ratio in the range 0.90:1.0 to 4.0:1.0, more preferably from 0.95:1.0 to 3.0:1.0.

P-containing detergent builders often preferred where permitted by legislation include, but are not limited to, the alkali metal, ammonium and alkanolammonium salts of polyphosphates exemplified by the tripolyphosphates, pyrophosphates, glassy polymeric meta-phosphates; and phosphonates.

Suitable carbonate builders include alkaline earth and alkali metal carbonates as disclosed in German Patent Application No. 2,321,001 published on November 15, 1973, although sodium bicarbonate, sodium carbonate, sodium sesquicarbonate, and other carbonate minerals such as trona or any convenient multiple salts of sodium carbonate and calcium carbonate such as those having the composition $2\text{Na}_2\text{CO}_3 \cdot \text{CaCO}_3$ when anhydrous, and even calcium carbonates including calcite, aragonite and vaterite, especially forms having high surface areas relative to compact calcite may be useful, for example as seeds or for use in synthetic detergent bars.

Suitable organic detergent builders include polycarboxylate compounds, including water-soluble nonsurfactant dicarboxylates and tricarboxylates. More typically builder polycarboxylates have a plurality of carboxylate groups, preferably at least 3 carboxylates. Carboxylate builders can be formulated in acid, partially

neutral, neutral or overbased form. When in salt form, alkali metals, such as sodium, potassium, and lithium, or alkanolammonium salts are preferred. Polycarboxylate builders include the ether polycarboxylates, such as oxydisuccinate, see Berg, U.S. 3,128,287, April 7, 1964, and Lamberti et al, U.S. 3,635,830, January 18, 1972; "TMS/TDS" builders of U.S. 4,663,071, Bush et al, May 5, 1987; and other ether carboxylates including cyclic and alicyclic compounds, such as those described in U.S. Patents 3,923,679; 3,835,163; 4,158,635; 4,120,874 and 4,102,903.

Other suitable builders are the ether hydroxypolycarboxylates, copolymers of maleic anhydride with ethylene or vinyl methyl ether; 1, 3, 5-trihydroxy benzene-2, 4, 6-trisulphonic acid; carboxymethyloxysuccinic acid; the various alkali metal, ammonium and substituted ammonium salts of polyacetic acids such as ethylenediamine tetraacetic acid and nitrilotriacetic acid; as well as mellitic acid, succinic acid, polymaleic acid, benzene 1,3,5-tricarboxylic acid, carboxymethyloxysuccinic acid, and soluble salts thereof.

Citrates, e.g., citric acid and soluble salts thereof are important carboxylate builders e.g., for heavy duty liquid detergents, due to availability from renewable resources and biodegradability. Citrates can also be used in granular compositions, especially in combination with zeolite and/or layered silicates. Oxydisuccinates are also especially useful in such compositions and combinations.

Where permitted, and especially in the formulation of bars used for hand-laundering operations, alkali metal phosphates such as sodium tripolyphosphates, sodium pyrophosphate and sodium orthophosphate can be used. Phosphonate builders such as ethane-1-hydroxy-1,1-diphosphonate and other known phosphonates, e.g., those of U.S. 3,159,581; 3,213,030; 3,422,021; 3,400,148 and 3,422,137 can also be used and may have desirable antiscaling properties.

Certain deterative surfactants or their short-chain homologs also have a builder action. For unambiguous formula accounting purposes, when they have surfactant capability, these materials are summed up as deterative surfactants. Preferred types for builder functionality are illustrated by: 3,3-dicarboxy-4-oxa-1,6-hexanedioates and the related compounds disclosed in U.S. 4,566,984, Bush, January 28, 1986. Succinic acid builders include the C₅-C₂₀ alkyl and alkenyl succinic acids and salts thereof. Succinate builders also include: laurylsuccinate, myristylsuccinate, palmitylsuccinate, 2-dodecenylsuccinate (preferred), 2-pentadecenylsuccinate, and the like. Lauryl-succinates are described in European Patent Application 86200690.5/0,200,263, published November 5, 1986. Fatty acids, e.g., C₁₂-C₁₈ monocarboxylic acids, can also be incorporated into the compositions as surfactant/builder materials alone or in combination with the

aforementioned builders, especially citrate and/or the succinate builders, to provide additional builder activity. Other suitable polycarboxylates are disclosed in U.S. 4,144,226, Crutchfield et al. March 13, 1979 and in U.S. 3,308,067, Diehl, March 7, 1967. See also Diehl, U.S. 3,723,322.

Other types of inorganic builder materials which can be used have the formula $(M_x)_i Ca_y (CO_3)_z$ wherein x and i are integers from 1 to 15, y is an integer from 1 to 10, z is an integer from 2 to 25, M_i are cations, at least one of which is a water-soluble, and the equation $\sum_{i=1}^{15} (x_i \text{ multiplied by the valence of } M_i) + 2y = 2z$ is satisfied such that the formula has a neutral or "balanced" charge. These builders are referred to herein as "Mineral Builders". Waters of hydration or anions other than carbonate may be added provided that the overall charge is balanced or neutral. The charge or valence effects of such anions should be added to the right side of the above equation. Preferably, there is present a water-soluble cation selected from the group consisting of hydrogen, water-soluble metals, hydrogen, boron, ammonium, silicon, and mixtures thereof, more preferably, sodium, potassium, hydrogen, lithium, ammonium and mixtures thereof, sodium and potassium being highly preferred. Nonlimiting examples of noncarbonate anions include those selected from the group consisting of chloride, sulfate, fluoride, oxygen, hydroxide, silicon dioxide, chromate, nitrate, borate and mixtures thereof. Preferred builders of this type in their simplest forms are selected from the group consisting of $Na_2Ca(CO_3)_2$, $K_2Ca(CO_3)_2$, $Na_2Ca_2(CO_3)_3$, $NaKCa(CO_3)_2$, $NaKCa_2(CO_3)_3$, $K_2Ca_2(CO_3)_3$, and combinations thereof. An especially preferred material for the builder described herein is $Na_2Ca(CO_3)_2$ in any of its crystalline modifications. Suitable builders of the above-defined type are further illustrated by, and include, the natural or synthetic forms of any one or combinations of the following minerals: Afghanite, Andersonite, AshcroftineY, Beyerite, Borcarite, Burbankite, Butschliite, Cancrinite, Carbocernaite, Carletonite, Davyne, DonnayiteY, Fairchildite, Ferrisurite, Franzinite, Gaudefroyite, Gaylussite, Girvasite, Gregoryite, Jouravskite, KamphaugiteY, Kettnerite, Khanneshite, LepersonniteGd, Liottite, MckelveyiteY, Microsommite, Mroseite, Natrofairchildite, Nyerereite, RemonditeCe, Sacrofanite, Schrockingerite, Shortite, Surite, Tunisite, Tuscanite, Tyrolite, Vishnevite, and Zemkorite. Preferred mineral forms include Nyerereite, Fairchildite and Shortite.

Polymeric Soil Release Agent - Known polymeric soil release agents, hereinafter "SRA" or "SRA's", can optionally be employed in the present detergent compositions. If utilized, SRA's will generally comprise from 0.01% to 10.0%, typically from 0.1% to 5%, preferably from 0.2% to 3.0% by weight, of the composition.

Preferred SRA's typically have hydrophilic segments to hydrophilize the surface of hydrophobic fibers such as polyester and nylon, and hydrophobic segments to deposit upon hydrophobic fibers and remain adhered thereto through completion of washing and rinsing cycles thereby serving as an anchor for the hydrophilic segments. This can enable stains occurring subsequent to treatment with SRA to be more easily cleaned in later washing procedures.

SRA's can include a variety of charged, e.g., anionic or even cationic (see U.S. 4,956,447), as well as noncharged monomer units and structures may be linear, branched or even star-shaped. They may include capping moieties which are especially effective in controlling molecular weight or altering the physical or surface-active properties. Structures and charge distributions may be tailored for application to different fiber or textile types and for varied detergent or detergent additive products.

Preferred SRA's include oligomeric terephthalate esters, typically prepared by processes involving at least one transesterification/oligomerization, often with a metal catalyst such as a titanium(IV) alkoxide. Such esters may be made using additional monomers capable of being incorporated into the ester structure through one, two, three, four or more positions, without of course forming a densely crosslinked overall structure.

Suitable SRA's include: a sulfonated product of a substantially linear ester oligomer comprised of an oligomeric ester backbone of terephthaloyl and oxyalkyleneoxy repeat units and allyl-derived sulfonated terminal moieties covalently attached to the backbone, for example as described in U.S. 4,968,451, November 6, 1990 to J.J. Scheibel and E.P. Gosselink; such ester oligomers can be prepared by (a) ethoxylating allyl alcohol, (b) reacting the product of (a) with dimethyl terephthalate ("DMT") and 1,2-propylene glycol ("PG") in a two-stage transesterification/oligomerization procedure and (c) reacting the product of (b) with sodium metabisulfite in water; the nonionic end-capped 1,2-propylene/polyoxyethylene terephthalate polyesters of U.S. 4,711,730, December 8, 1987 to Gosselink et al, for example those produced by transesterification/oligomerization of poly(ethyleneglycol) methyl ether, DMT, PG and poly(ethyleneglycol) ("PEG"); the partly- and fully- anionic-end-capped oligomeric esters of U.S. 4,721,580, January 26, 1988 to Gosselink, such as oligomers from ethylene glycol ("EG"), PG, DMT and Na-3,6-dioxa-8-hydroxyoctanesulfonate; the nonionic-capped block polyester oligomeric compounds of U.S. 4,702,857, October 27, 1987 to Gosselink, for example produced from DMT, Me-capped PEG and EG and/or PG, or a combination of

DMT, EG and/or PG, Me-capped PEG and Na-dimethyl-5-sulfoisophthalate; and the anionic, especially sulfoaroyl, end-capped terephthalate esters of U.S. 4,877,896, October 31, 1989 to Maldonado, Gosselink et al, the latter being typical of SRA's useful in both laundry and fabric conditioning products, an example being an ester composition made from m-sulphobenzoic acid monosodium salt, PG and DMT optionally but preferably further comprising added PEG, e.g., PEG 3400.

SRA's also include simple copolymeric blocks of ethylene terephthalate or propylene terephthalate with polyethylene oxide or polypropylene oxide terephthalate, see U.S. 3,959,230 to Hays, May 25, 1976 and U.S. 3,893,929 to Basadur, July 8, 1975; cellulosic derivatives such as the hydroxyether cellulosic polymers available as METHOCEL from Dow; and the C₁-C₄ alkylcelluloses and C₄ hydroxyalkyl celluloses; see U.S. 4,000,093, December 28, 1976 to Nicol, et al. Suitable SRA's characterised by poly(vinyl ester) hydrophobe segments include graft copolymers of poly(vinyl ester), e.g., C₁-C₆ vinyl esters, preferably poly(vinyl acetate), grafted onto polyalkylene oxide backbones. See European Patent Application 0 219 048, published April 22, 1987 by Kud, et al. Commercially available examples include SOKALAN SRA's such as SOKALAN HP-22, available from BASF, Germany. Other SRA's are polyesters with repeat units containing 10-15% by weight of ethylene terephthalate together with 90-80% by weight of polyoxyethylene terephthalate, derived from a polyoxyethylene glycol of average molecular weight 300-5,000. Commercial examples include ZELCON 5126 from Dupont and MILEASE T from ICI.

Another preferred SRA is an oligomer having empirical formula (CAP)₂(EG/PG)₅(T)₅(SIP)₁ which comprises terephthaloyl (T), sulfoisophthaloyl (SIP), oxyethyleneoxy and oxy-1,2-propylene (EG/PG) units and which is preferably terminated with end-caps (CAP), preferably modified isethionates, as in an oligomer comprising one sulfoisophthaloyl unit, 5 terephthaloyl units, oxyethyleneoxy and oxy-1,2-propyleneoxy units in a defined ratio, preferably about 0.5:1 to about 10:1, and two end-cap units derived from sodium 2-(2-hydroxyethoxy)-ethanesulfonate. Said SRA preferably further comprises from 0.5% to 20%, by weight of the oligomer, of a crystallinity-reducing stabiliser, for example an anionic surfactant such as linear sodium dodecylbenzenesulfonate or a member selected from xylene-, cumene-, and toluene- sulfonates or mixtures thereof, these stabilizers or modifiers being introduced into the synthesis pot, all as taught in U.S. 5,415,807, Gosselink, Pan, Kellett and Hall, issued May 16, 1995. Suitable monomers for the above SRA include Na 2-(2-hydroxyethoxy)-ethanesulfonate, DMT, Na- dimethyl 5-sulfoisophthalate, EG and PG.

- Yet another group of preferred SRA's are oligomeric esters comprising: (1) a backbone comprising (a) at least one unit selected from the group consisting of dihydroxysulfonates, polyhydroxy sulfonates, a unit which is at least trifunctional whereby ester linkages are formed resulting in a branched oligomer backbone, and combinations thereof; (b) at least one unit which is a terephthaloyl moiety; and (c) at least one unsulfonated unit which is a 1,2-oxyalkyleneoxy moiety; and (2) one or more capping units selected from nonionic capping units, anionic capping units such as alkoxylated, preferably ethoxylated, isethionates, alkoxylated propanesulfonates, alkoxylated propanedisulfonates, alkoxylated phenolsulfonates, sulfoaroyl derivatives and mixtures thereof. Preferred of such esters are those of empirical formula:



wherein CAP, EG/PG, PEG, T and SIP are as defined hereinabove, (DEG) represents di(oxyethylene)oxy units; (SEG) represents units derived from the sulfoethyl ether of glycerin and related moiety units; (B) represents branching units which are at least trifunctional whereby ester linkages are formed resulting in a branched oligomer backbone; x is from about 1 to about 12; y' is from about 0.5 to about 25; y'' is from 0 to about 12; y''' is from 0 to about 10; y'+y''+y''' totals from about 0.5 to about 25; z is from about 1.5 to about 25; z' is from 0 to about 12; z + z' totals from about 1.5 to about 25; q is from about 0.05 to about 12; m is from about 0.01 to about 10; and x, y', y'', y''', z, z', q and m represent the average number of moles of the corresponding units per mole of said ester and said ester has a molecular weight ranging from about 500 to about 5,000.

Preferred SEG and CAP monomers for the above esters include Na-2-(2,3-dihydroxypropoxy)ethanesulfonate ("SEG"), Na-2-{2-(2-hydroxyethoxy) ethoxy} ethanesulfonate ("SE3") and its homologs and mixtures thereof and the products of ethoxylating and sulfonating allyl alcohol. Preferred SRA esters in this class include the product of transesterifying and oligomerizing sodium 2-{2-(2-hydroxyethoxy)ethoxy}ethanesulfonate and/or sodium 2-[2-{2-(2-hydroxyethoxy)-ethoxy}ethoxy]ethanesulfonate, DMT, sodium 2-(2,3-dihydroxypropoxy) ethane sulfonate, EG, and PG using an appropriate Ti(IV) catalyst and can be designated as (CAP)₂(T)₅(EG/PG)_{1.4}(SEG)_{2.5}(B)_{0.13} wherein CAP is (Na⁺ - O₃S[CH₂CH₂O]_{3.5})- and B is a unit from glycerin and the mole ratio EG/PG is about 1.7:1 as measured by conventional gas chromatography after complete hydrolysis.

Additional classes of SRA's include (I) nonionic terephthalates using diisocyanate coupling agents to link up polymeric ester structures, see U.S.

4,201,824, Violland et al. and U.S. 4,240,918 Lagasse et al; (II) SRA's with carboxylate terminal groups made by adding trimellitic anhydride to known SRA's to convert terminal hydroxyl groups to trimellitate esters. With a proper selection of catalyst, the trimellitic anhydride forms linkages to the terminals of the polymer through an ester of the isolated carboxylic acid of trimellitic anhydride rather than by opening of the anhydride linkage. Either nonionic or anionic SRA's may be used as starting materials as long as they have hydroxyl terminal groups which may be esterified. See U.S. 4,525,524 Tung et al.; (III) anionic terephthalate-based SRA's of the urethane-linked variety, see U.S. 4,201,824, Violland et al; (IV) poly(vinyl caprolactam) and related co-polymers with monomers such as vinyl pyrrolidone and/or dimethylaminoethyl methacrylate, including both nonionic and cationic polymers, see U.S. 4,579,681, Ruppert et al.; (V) graft copolymers, in addition to the SOKALAN types from BASF made by grafting acrylic monomers on to sulfonated polyesters; these SRA's assertedly have soil release and anti-redeposition activity similar to known cellulose ethers: see EP 279,134 A, 1988, to Rhone-Poulenc Chemie; (VI) grafts of vinyl monomers such as acrylic acid and vinyl acetate on to proteins such as caseins, see EP 457,205 A to BASF (1991); (VII) polyester-polyamide SRA's prepared by condensing adipic acid, caprolactam, and polyethylene glycol, especially for treating polyamide fabrics, see Bevan et al, DE 2,335,044 to Unilever N. V., 1974. Other useful SRA's are described in U.S. Patents 4,240,918, 4,787,989, 4,525,524 and 4,877,896.

Clay Soil Removal/Anti-redeposition Agents - The compositions of the present invention can also optionally contain water-soluble ethoxylated amines having clay soil removal and antiredeposition properties. Granular detergent compositions which contain these compounds typically contain from about 0.01% to about 10.0% by weight of the water-soluble ethoxylates amines; liquid detergent compositions typically contain about 0.01% to about 5%.

The most preferred soil release and anti-redeposition agent is ethoxylated tetraethylenepentamine. Exemplary ethoxylated amines are further described in U.S. Patent 4,597,898, VanderMeer, issued July 1, 1986. Another group of preferred clay soil removal-antiredeposition agents are the cationic compounds disclosed in European Patent Application 111,965, Oh and Gosselink, published June 27, 1984. Other clay soil removal/antiredeposition agents which can be used include the ethoxylated amine polymers disclosed in European Patent Application 111,984, Gosselink, published June 27, 1984; the zwitterionic polymers disclosed in European Patent Application 112,592, Gosselink, published July 4, 1984; and the amine oxides disclosed in U.S. Patent 4,548,744, Connor, issued October 22, 1985.

Other clay soil removal and/or anti redeposition agents known in the art can also be utilized in the compositions herein. See U.S. Patent 4,891,160, VanderMeer, issued January 2, 1990 and WO 95/32272, published November 30, 1995. Another type of preferred antiredeposition agent includes the carboxy methyl cellulose (CMC) materials. These materials are well known in the art.

Polymeric Dispersing Agents - Polymeric dispersing agents can advantageously be utilized at levels from about 0.1% to about 7%, by weight, in the compositions herein, especially in the presence of zeolite and/or layered silicate builders. Suitable polymeric dispersing agents include polymeric polycarboxylates and polyethylene glycols, although others known in the art can also be used. It is believed, though it is not intended to be limited by theory, that polymeric dispersing agents enhance overall detergent builder performance, when used in combination with other builders (including lower molecular weight polycarboxylates) by crystal growth inhibition, particulate soil release peptization, and anti-redeposition.

Polymeric polycarboxylate materials can be prepared by polymerizing or copolymerizing suitable unsaturated monomers, preferably in their acid form. Unsaturated monomeric acids that can be polymerized to form suitable polymeric polycarboxylates include acrylic acid, maleic acid (or maleic anhydride), fumaric acid, itaconic acid, aconitic acid, mesaconic acid, citraconic acid and methylenemalononic acid. The presence in the polymeric polycarboxylates herein or monomeric segments, containing no carboxylate radicals such as vinylmethyl ether, styrene, ethylene, etc. is suitable provided that such segments do not constitute more than about 40% by weight.

Particularly suitable polymeric polycarboxylates can be derived from acrylic acid. Such acrylic acid-based polymers which are useful herein are the water-soluble salts of polymerized acrylic acid. The average molecular weight of such polymers in the acid form preferably ranges from about 2,000 to 10,000, more preferably from about 4,000 to 7,000 and most preferably from about 4,000 to 5,000. Water-soluble salts of such acrylic acid polymers can include, for example, the alkali metal, ammonium and substituted ammonium salts. Soluble polymers of this type are known materials. Use of polyacrylates of this type in detergent compositions has been disclosed, for example, in Diehl, U.S. Patent 3,308,067, issued march 7, 1967.

Acrylic/maleic-based copolymers may also be used as a preferred component of the dispersing/anti-redeposition agent. Such materials include the water-soluble salts of copolymers of acrylic acid and maleic acid. The average molecular weight of such copolymers in the acid form preferably ranges from about 2,000 to 100,000,

more preferably from about 5,000 to 75,000, most preferably from about 7,000 to 65,000. The ratio of acrylate to maleate segments in such copolymers will generally range from about 30:1 to about 1:1, more preferably from about 10:1 to 2:1. Water-soluble salts of such acrylic acid/maleic acid copolymers can include, for example, the alkali metal, ammonium and substituted ammonium salts. Soluble acrylate/maleate copolymers of this type are known materials which are described in European Patent Application No. 66915, published December 15, 1982, as well as in EP 193,360, published September 3, 1986, which also describes such polymers comprising hydroxypropylacrylate. Still other useful dispersing agents include the maleic/acrylic/vinyl alcohol terpolymers. Such materials are also disclosed in EP 193,360, including, for example, the 45/45/10 terpolymer of acrylic/maleic/vinyl alcohol.

Another polymeric material which can be included is polyethylene glycol (PEG). PEG can exhibit dispersing agent performance as well as act as a clay soil removal-antiredeposition agent. Typical molecular weight ranges for these purposes range from about 500 to about 100,000, preferably from about 1,000 to about 50,000, more preferably from about 1,500 to about 10,000.

Polyaspartate and polyglutamate dispersing agents may also be used, especially in conjunction with zeolite builders. Dispersing agents such as polyaspartate preferably have a molecular weight (avg.) of about 10,000.

Brightener - Any optical brighteners or other brightening or whitening agents known in the art can be incorporated at levels typically from about 0.01% to about 1.2%, by weight, into the detergent compositions herein. Commercial optical brighteners which may be useful in the present invention can be classified into subgroups, which include, but are not necessarily limited to, derivatives of stilbene, pyrazoline, coumarin, carboxylic acid, methinecyanines, dibenzothiophene-5,5-dioxide, azoles, 5- and 6-membered-ring heterocycles, and other miscellaneous agents. Examples of such brighteners are disclosed in "The Production and Application of Fluorescent Brightening Agents", M. Zahradnik, Published by John Wiley & Sons, New York (1982).

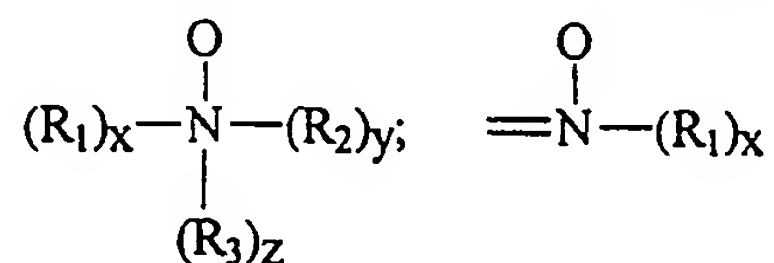
Specific examples of optical brighteners which are useful in the present compositions are those identified in U.S. Patent 4,790,856, issued to Wixon on December 13, 1988. These brighteners include the PHORWHITE series of brighteners from Verona. Other brighteners disclosed in this reference include: Tinopal UNPA, Tinopal CBS and Tinopal 5BM; available from Ciba-Geigy; Artic White CC and Artic White CWD, the 2-(4-styryl-phenyl)-2H-naphtho[1,2-d]triazoles; 4,4'-bis-(1,2,3-triazol-2-yl)-stilbenes; 4,4'-bis(styryl)bisphenyls; and the amino-

coumarins. Specific examples of these brighteners include 4-methyl-7-diethyl-amino coumarin; 1,2-bis(benzimidazol-2-yl)ethylene; 1,3-diphenyl-pyrazolines; 2,5-bis(benzoxazol-2-yl)thiophene; 2-styryl-naphtho[1,2-d]oxazole; and 2-(stilben-4-yl)-2H-naphtho[1,2-d]triazole. See also U.S. Patent 3,646,015, issued February 29, 1972 to Hamilton.

Dye Transfer Inhibiting Agents - The compositions of the present invention may also include one or more materials effective for inhibiting the transfer of dyes from one fabric to another during the cleaning process. Generally, such dye transfer inhibiting agents include polyvinyl pyrrolidone polymers, polyamine N-oxide polymers, copolymers of N-vinylpyrrolidone and N-vinylimidazole, manganese phthalocyanine, peroxidases, and mixtures thereof. If used, these agents typically comprise from about 0.01% to about 10% by weight of the composition, preferably from about 0.01% to about 5%, and more preferably from about 0.05% to about 2%.

More specifically, the polyamine N-oxide polymers preferred for use herein contain units having the following structural formula: $R-A_x-P$; wherein P is a polymerizable unit to which an N-O group can be attached or the N-O group can form part of the polymerizable unit or the N-O group can be attached to both units; A is one of the following structures: $-NC(O)-$, $-C(O)O-$, $-S-$, $-O-$, $-N=$; x is 0 or 1; and R is aliphatic, ethoxylated aliphatics, aromatics, heterocyclic or alicyclic groups or any combination thereof to which the nitrogen of the N-O group can be attached or the N-O group is part of these groups. Preferred polyamine N-oxides are those wherein R is a heterocyclic group such as pyridine, pyrrole, imidazole, pyrrolidine, piperidine and derivatives thereof.

The N-O group can be represented by the following general structures:



wherein R_1 , R_2 , R_3 are aliphatic, aromatic, heterocyclic or alicyclic groups or combinations thereof; x, y and z are 0 or 1; and the nitrogen of the N-O group can be attached or form part of any of the aforementioned groups. The amine oxide unit of the polyamine N-oxides has a $pK_a < 10$, preferably $pK_a < 7$, more preferred $pK_a < 6$.

Any polymer backbone can be used as long as the amine oxide polymer formed is water-soluble and has dye transfer inhibiting properties. Examples of suitable polymeric backbones are polyvinyls, polyalkylenes, polyesters, polyethers, polyamide, polyimides, polyacrylates and mixtures thereof. These polymers include

random or block copolymers where one monomer type is an amine N-oxide and the other monomer type is an N-oxide. The amine N-oxide polymers typically have a ratio of amine to the amine N-oxide of 10:1 to 1:1,000,000. However, the number of amine oxide groups present in the polyamine oxide polymer can be varied by appropriate copolymerization or by an appropriate degree of N-oxidation. The polyamine oxides can be obtained in almost any degree of polymerization. Typically, the average molecular weight is within the range of 500 to 1,000,000; more preferred 1,000 to 500,000; most preferred 5,000 to 100,000. This preferred class of materials can be referred to as "PVNO".

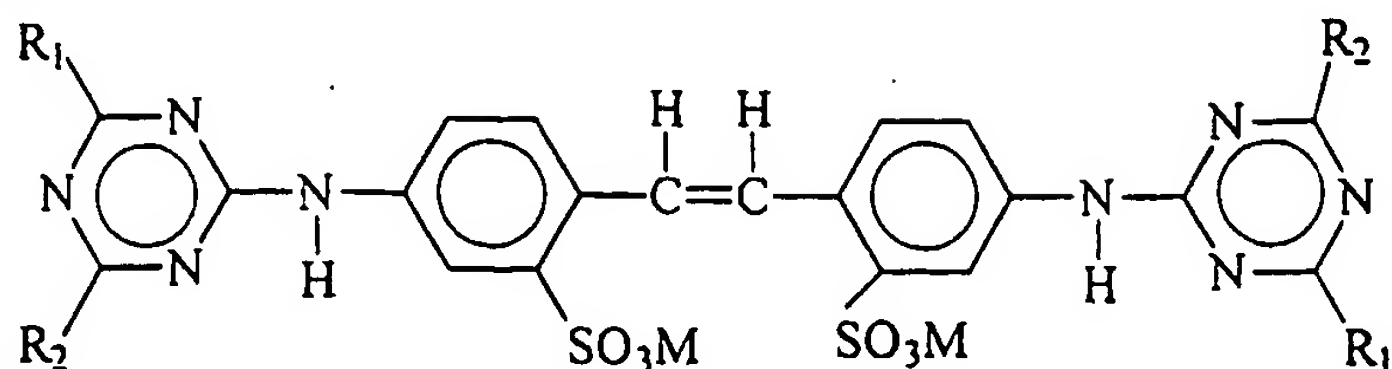
The most preferred polyamine N-oxide useful in the detergent compositions herein is poly(4-vinylpyridine-N-oxide) which has an average molecular weight of about 50,000 and an amine to amine N-oxide ratio of about 1:4.

Copolymers of N-vinylpyrrolidone and N-vinylimidazole polymers (referred to as a class as "PVPVI") are also preferred for use herein. Preferably the PVPVI has an average molecular weight range from 5,000 to 1,000,000, more preferably from 5,000 to 200,000, and most preferably from 10,000 to 20,000. (The average molecular weight range is determined by light scattering as described in Barth, et al., Chemical Analysis, Vol 113. "Modern Methods of Polymer Characterization", the disclosures of which are incorporated herein by reference.) The PVPVI copolymers typically have a molar ratio of N-vinylimidazole to N-vinylpyrrolidone from 1:1 to 0.2:1, more preferably from 0.8:1 to 0.3:1, most preferably from 0.6:1 to 0.4:1. These copolymers can be either linear or branched.

The present invention compositions also may employ a polyvinylpyrrolidone ("PVP") having an average molecular weight of from about 5,000 to about 400,000, preferably from about 5,000 to about 200,000, and more preferably from about 5,000 to about 50,000. PVP's are known to persons skilled in the detergent field; see, for example, EP-A-262,897 and EP-A-256,696, incorporated herein by reference. Compositions containing PVP can also contain polyethylene glycol ("PEG") having an average molecular weight from about 500 to about 100,000, preferably from about 1,000 to about 10,000. Preferably, the ratio of PEG to PVP on a ppm basis delivered in wash solutions is from about 2:1 to about 50:1, and more preferably from about 3:1 to about 10:1.

The detergent compositions herein may also optionally contain from about 0.005% to 5% by weight of certain types of hydrophilic optical brighteners which also provide a dye transfer inhibition action. If used, the compositions herein will preferably comprise from about 0.01% to 1% by weight of such optical brighteners.

The hydrophilic optical brighteners useful in the present invention are those having the structural formula:



wherein R_1 is selected from anilino, N-2-bis-hydroxyethyl and NH-2-hydroxyethyl; R_2 is selected from N-2-bis-hydroxyethyl, N-2-hydroxyethyl-N-methylamino, morphilino, chloro and amino; and M is a salt-forming cation such as sodium or potassium.

When in the above formula, R_1 is anilino, R_2 is N-2-bis-hydroxyethyl and M is a cation such as sodium, the brightener is 4,4'-bis[(4-anilino-6-(N-2-bis-hydroxyethyl)-s-triazine-2-yl)amino]-2,2'-stilbenedisulfonic acid and disodium salt. This particular brightener species is commercially marketed under the tradename Tinopal-UNPA-GX by Ciba-Geigy Corporation. Tinopal-UNPA-GX is the preferred hydrophilic optical brightener useful in the detergent compositions herein.

When in the above formula, R_1 is anilino, R_2 is N-2-hydroxyethyl-N-2-methylamino and M is a cation such as sodium, the brightener is 4,4'-bis[(4-anilino-6-(N-2-hydroxyethyl-N-methylamino)-s-triazine-2-yl)amino]-2,2'-stilbenedisulfonic acid disodium salt. This particular brightener species is commercially marketed under the tradename Tinopal 5BM-GX by Ciba-Geigy Corporation.

When in the above formula, R_1 is anilino, R_2 is morphilino and M is a cation such as sodium, the brightener is 4,4'-bis[(4-anilino-6-morphilino-s-triazine-2-yl)amino]-2,2'-stilbenedisulfonic acid, sodium salt. This particular brightener species is commercially marketed under the tradename Tinopal AMS-GX by Ciba Geigy Corporation.

The specific optical brightener species selected for use in the present invention provide especially effective dye transfer inhibition performance benefits when used in combination with the selected polymeric dye transfer inhibiting agents hereinbefore described. The combination of such selected polymeric materials (e.g., PVNO and/or PVPVI) with such selected optical brighteners (e.g., Tinopal UNPA-GX, Tinopal 5BM-GX and/or Tinopal AMS-GX) provides significantly better dye transfer inhibition in aqueous wash solutions than does either of these two detergent composition components when used alone. Without being bound by theory, it is believed that such brighteners work this way because they have high affinity for fabrics in the wash solution and therefore deposit relatively quick on these fabrics.

The extent to which brighteners deposit on fabrics in the wash solution can be defined by a parameter called the "exhaustion coefficient". The exhaustion coefficient is in general as the ratio of a) the brightener material deposited on fabric to b) the initial brightener concentration in the wash liquor. Brighteners with relatively high exhaustion coefficients are the most suitable for inhibiting dye transfer in the context of the present invention.

Of course, it will be appreciated that other, conventional optical brightener types of compounds can optionally be used in the present compositions to provide conventional fabric "brightness" benefits, rather than a true dye transfer inhibiting effect. Such usage is conventional and well-known to detergent formulations.

Chelating Agents - The detergent compositions herein may also optionally contain one or more iron and/or manganese chelating agents. Such chelating agents can be selected from the group consisting of amino carboxylates, amino phosphonates, polyfunctionally-substituted aromatic chelating agents and mixtures therein, all as hereinafter defined. Without intending to be bound by theory, it is believed that the benefit of these materials is due in part to their exceptional ability to remove iron and manganese ions from washing solutions by formation of soluble chelates.

Amino carboxylates useful as optional chelating agents include ethylenediaminetetracetates, N-hydroxyethylethylenediaminetriacetates, nitrilotriacetates, ethylenediamine tetrapropionates, triethylenetetraaminehexacetates, diethylenetriaminepentaacetates, and ethanoldiglycines, alkali metal ammonium, and substituted ammonium salts therein and mixtures therein.

Amino phosphonates are also suitable for use as chelating agents in the compositions of the invention when at least low levels of total phosphorus are permitted in detergent compositions, and include ethylenediaminetetrakis (methylenephosphonates) as DEQUEST. Preferred, these amino phosphonates to not contain alkyl or alkenyl groups with more than about 6 carbon atoms.

Polyfunctionally-substituted aromatic chelating agents are also useful in the compositions herein. See U.S. Patent 3,812,044, issued May 21, 1974, to Connor et al. Preferred compounds of this type in acid form are dihydroxydisulfobenzenes such as 1,2-dihydroxy-3,5-disulfobenzene.

A preferred biodegradable chelator for use herein is ethylenediamine disuccinate ("EDDS"), especially the [S,S] isomer as described in U.S. Patent 4,704,233, November 3, 1987, to Hartman and Perkins.

- The compositions herein may also contain water-soluble methyl glycine diacetic acid (MGDA) salts (or acid form) as a chelant or co-builder useful with, for example, insoluble builders such as zeolites, layered silicates and the like.

If utilized, these chelating agents will generally comprise from about 0.1% to about 15% by weight of the detergent compositions herein. More preferably, if utilized, the chelating agents will comprise from about 0.1% to about 3.0% by weight of such compositions.

Suds Suppressors - Compounds for reducing or suppressing the formation of suds can be incorporated into the compositions of the present invention. Suds suppression can be of particular importance in the so-called "high concentration cleaning process" as described in U.S. 4,489,455 and 4,489,574 and in front-loading European-style washing machines.

A wide variety of materials may be used as suds suppressors, and suds suppressors are well known to those skilled in the art. See, for example, Kirk Othmer Encyclopedia of Chemical Technology, Third Edition, Volume 7, pages 430-447 (John Wiley & Sons, Inc., 1979). One category of suds suppressor of particular interest encompasses monocarboxylic fatty acid and soluble salts therein. See U.S. Patent 2,954,347, issued September 27, 1960 to Wayne St. John. The monocarboxylic fatty acids and salts thereof used as suds suppressor typically have hydrocarbyl chains of 10 to about 24 carbon atoms, preferably 12 to 18 carbon atoms. Suitable salts include the alkali metal salts such as sodium, potassium, and lithium salts, and ammonium and alkanolammonium salts.

The detergent compositions herein may also contain non-surfactant suds suppressors. These include, for example: high molecular weight hydrocarbons such as paraffin, fatty acid esters (e.g., fatty acid triglycerides), fatty acid esters of monovalent alcohols, aliphatic C₁₈-C₄₀ ketones (e.g., stearone), etc. Other suds inhibitors include N-alkylated amino triazines such as tri- to hexa-alkylmelamines or di- to tetra-alkyldiamine chlortriazines formed as products of cyanuric chloride with two or three moles of a primary or secondary amine containing 1 to 24 carbon atoms, propylene oxide, and monostearyl phosphates such as monostearyl alcohol phosphate ester and monostearyl di-alkali metal (e.g., K, Na, and Li) phosphates and phosphate esters. The hydrocarbons such as paraffin and haloparaffin can be utilized in liquid form. The liquid hydrocarbons will be liquid at room temperature and atmospheric pressure, and will have a pour point in the range of about -40°C and about 50°C, and a minimum boiling point not less than about 110°C (atmospheric pressure). It is also known to utilize waxy hydrocarbons, preferably having a melting point below about 100°C. The hydrocarbons constitute a preferred category

of suds suppressor for detergent compositions. Hydrocarbon suds suppressors are described, for example, in U.S. Patent 4,265,779, issued May 5, 1981 to Gandolfo et al. The hydrocarbons, thus, include aliphatic, alicyclic, aromatic, and heterocyclic saturated or unsaturated hydrocarbons having from about 12 to about 70 carbon atoms. The term "paraffin," as used in this suds suppressor discussion, is intended to include mixtures of true paraffins and cyclic hydrocarbons.

Another preferred category of non-surfactant suds suppressors comprises silicone suds suppressors. This category includes the use of polyorganosiloxane oils, such as polydimethylsiloxane, dispersions or emulsions of polyorganosiloxane oils or resins, and combinations of polyorganosiloxane with silica particles wherein the polyorganosiloxane is chemisorbed or fused onto the silica. Silicone suds suppressors are well known in the art and are, for example, disclosed in U.S. Patent 4,265,779, issued May 5, 1981 to Gandolfo et al and European Patent Application No. 89307851.9, published February 7, 1990, by Starch, M. S.

Other silicone suds suppressors are disclosed in U.S. Patent 3,455,839 which relates to compositions and processes for defoaming aqueous solutions by incorporating therein small amounts of polydimethylsiloxane fluids.

Mixtures of silicone and silanated silica are described, for instance, in German Patent Application DOS 2,124,526. Silicone defoamers and suds controlling agents in granular detergent compositions are disclosed in U.S. Patent 3,933,672, Bartolotta et al, and in U.S. Patent 4,652,392, Baginski et al, issued March 24, 1987.

An exemplary silicone based suds suppressor for use herein is a suds suppressing amount of a suds controlling agent consisting essentially of:

- (i) polydimethylsiloxane fluid having a viscosity of from about 20 cs. to about 1,500 cs. at 25°C;
- (ii) from about 5 to about 50 parts per 100 parts by weight of (i) of siloxane resin composed of $(\text{CH}_3)_3\text{SiO}_{1/2}$ units of SiO_2 units in a ratio of from $(\text{CH}_3)_3\text{SiO}_{1/2}$ units and to SiO_2 units of from about 0.6:1 to about 1.2:1; and
- (iii) from about 1 to about 20 parts per 100 parts by weight of (i) of a solid silica gel.

In the preferred silicone suds suppressor used herein, the solvent for a continuous phase is made up of certain polyethylene glycols or polyethylene-polypropylene glycol copolymers or mixtures thereof (preferred), or polypropylene glycol. The primary silicone suds suppressor is branched/crosslinked and preferably not linear.

- To illustrate this point further, typical liquid laundry detergent compositions with controlled suds will optionally comprise from about 0.001 to about 1, preferably from about 0.01 to about 0.7, most preferably from about 0.05 to about 0.5, weight % of said silicone suds suppressor, which comprises (1) a nonaqueous emulsion of a primary antifoam agent which is a mixture of (a) a polyorganosiloxane, (b) a resinous siloxane or a silicone resin-producing silicone compound, (c) a finely divided filler material, and (d) a catalyst to promote the reaction of mixture components (a), (b) and (c), to form silanolates; (2) at least one nonionic silicone surfactant; and (3) polyethylene glycol or a copolymer of polyethylene-polypropylene glycol having a solubility in water at room temperature of more than about 2 weight %; and without polypropylene glycol. Similar amounts can be used in granular compositions, gels, etc. See also U.S. Patents 4,978,471, Starch, issued December 18, 1990, and 4,983,316, Starch, issued January 8, 1991, 5,288,431, Huber et al., issued February 22, 1994, and U.S. Patents 4,639,489 and 4,749,740, Aizawa et al at column 1, line 46 through column 4, line 35.

The silicone suds suppressor herein preferably comprises polyethylene glycol and a copolymer of polyethylene glycol/polypropylene glycol, all having an average molecular weight of less than about 1,000, preferably between about 100 and 800. The polyethylene glycol and polyethylene/polypropylene copolymers herein have a solubility in water at room temperature of more than about 2 weight %, preferably more than about 5 weight %.

The preferred solvent herein is polyethylene glycol having an average molecular weight of less than about 1,000, more preferably between about 100 and 800, most preferably between 200 and 400, and a copolymer of polyethylene glycol/polypropylene glycol, preferably PPG 200/PEG 300. Preferred is a weight ratio of between about 1:1 and 1:10, most preferably between 1:3 and 1:6, of polyethylene glycol:copolymer of polyethylene-polypropylene glycol.

The preferred silicone suds suppressors used herein do not contain polypropylene glycol, particularly of 4,000 molecular weight. They also preferably do not contain block copolymers of ethylene oxide and propylene oxide, like PLURONIC L101.

Other suds suppressors useful herein comprise the secondary alcohols (e.g., 2-alkyl alkanols) and mixtures of such alcohols with silicone oils, such as the silicones disclosed in U.S. 4,798,679, 4,075,118 and EP 150,872. The secondary alcohols include the C₆-C₁₆ alkyl alcohols having a C₁-C₁₆ chain. A preferred alcohol is 2-butyl octanol, which is available from Condea under the trademark ISOFOL 12. Mixtures of secondary alcohols are available under the trademark

ISALCHEM 123 from Enichem. Mixed suds suppressors typically comprise mixtures of alcohol + silicone at a weight ratio of 1:5 to 5:1.

For any detergent compositions to be used in automatic laundry washing machines, suds should not form to the extent that they overflow the washing machine. Suds suppressors, when utilized, are preferably present in a "suds suppressing amount." By "suds suppressing amount" is meant that the formulator of the composition can select an amount of this suds controlling agent that will sufficiently control the suds to result in a low-sudsing laundry detergent for use in automatic laundry washing machines.

The compositions herein will generally comprise from 0% to about 10% of suds suppressor. When utilized as suds suppressors, monocarboxylic fatty acids, and salts therein, will be present typically in amounts up to about 5%, by weight, of the detergent composition. Preferably, from about 0.5% to about 3% of fatty monocarboxylate suds suppressor is utilized. Silicone suds suppressors are typically utilized in amounts up to about 2.0%, by weight, of the detergent composition, although higher amounts may be used. This upper limit is practical in nature, due primarily to concern with keeping costs minimized and effectiveness of lower amounts for effectively controlling sudsing. Preferably from about 0.01% to about 1% of silicone suds suppressor is used, more preferably from about 0.25% to about 0.5%. As used herein, these weight percentage values include any silica that may be utilized in combination with polyorganosiloxane, as well as any adjunct materials that may be utilized. Monostearyl phosphate suds suppressors are generally utilized in amounts ranging from about 0.1% to about 2%, by weight, of the composition. Hydrocarbon suds suppressors are typically utilized in amounts ranging from about 0.01% to about 5.0%, although higher levels can be used. The alcohol suds suppressors are typically used at 0.2%-3% by weight of the finished compositions.

Alkoxyated Polycarboxylates - Alkoxyated polycarboxylates such as those prepared from polyacrylates are useful herein to provide additional grease removal performance. Such materials are described in WO 91/08281 and PCT 90/01815 at p. 4 et seq., incorporated herein by reference. Chemically, these materials comprise polyacrylates having one ethoxy side-chain per every 7-8 acrylate units. The side-chains are of the formula $-(CH_2CH_2O)_m(CH_2)_nCH_3$ wherein m is 2-3 and n is 6-12. The side-chains are ester-linked to the polyacrylate "backbone" to provide a "comb" polymer type structure. The molecular weight can vary, but is typically in the range of about 2000 to about 50,000. Such alkoxyated polycarboxylates can comprise from about 0.05% to about 10%, by weight, of the compositions herein.

- Fabric Softeners - Various through-the-wash fabric softeners, especially the impalpable smectite clays of U.S. Patent 4,062,647, Storm and Nirschl, issued December 13, 1977, as well as other softener clays known in the art, can optionally be used typically at levels of from about 0.5% to about 10% by weight in the present compositions to provide fabric softener benefits concurrently with fabric cleaning. Clay softeners can be used in combination with amine and cationic softeners as disclosed, for example, in U.S. Patent 4,375,416, Crisp et al, March 1, 1983 and U.S. Patent 4,291,071, Harris et al, issued September 22, 1981.

Perfumes - Perfumes and perfumery ingredients useful in the present compositions and processes comprise a wide variety of natural and synthetic chemical ingredients, including, but not limited to, aldehydes, ketones, esters, and the like. Also included are various natural extracts and essences which can comprise complex mixtures of ingredients, such as orange oil, lemon oil, rose extract, lavender, musk, patchouli, balsamic essence, sandalwood oil, pine oil, cedar, and the like. Finished perfumes can comprise extremely complex mixtures of such ingredients. Finished perfumes typically comprise from about 0.01% to about 2%, by weight, of the detergent compositions herein, and individual perfumery ingredients can comprise from about 0.0001% to about 90% of a finished perfume composition.

Several perfume formulations are set forth in Example XXI, hereinafter. Non-limiting examples of perfume ingredients useful herein include: 7-acetyl-1,2,3,4,5,6,7,8-octahydro-1,1,6,7-tetramethyl naphthalene; ionone methyl; ionone gamma methyl; methyl cedrylone; methyl dihydrojasmonate; methyl 1,6,10-trimethyl-2,5,9-cyclododecatrien-1-yl ketone; 7-acetyl-1,1,3,4,4,6-hexamethyl tetralin; 4-acetyl-6-tert-butyl-1,1-dimethyl indane; para-hydroxy-phenyl-butanone; benzophenone; methyl beta-naphthyl ketone; 6-acetyl-1,1,2,3,3,5-hexamethyl indane; 5-acetyl-3-isopropyl-1,1,2,6-tetramethyl indane; 1-dodecanal, 4-(4-hydroxy-4-methylpentyl)-3-cyclohexene-1-carboxaldehyde; 7-hydroxy-3,7-dimethyl octanal; 10-undecen-1-al; iso-hexenyl cyclohexyl carboxaldehyde; formyl tricyclodecane; condensation products of hydroxycitronellal and methyl anthranilate, condensation products of hydroxycitronellal and indol, condensation products of phenyl acetaldehyde and indol; 2-methyl-3-(para-tert-butylphenyl)-propionaldehyde; ethyl vanillin; heliotropin; hexyl cinnamic aldehyde; amyl cinnamic aldehyde; 2-methyl-2-(para-iso-propylphenyl)-propionaldehyde; coumarin; decalactone gamma; cyclopentadecanolide; 16-hydroxy-9-hexadecenoic acid lactone; 1,3,4,6,7,8-hexahydro-4,6,6,7,8,8-hexamethylcyclopenta-gamma-2-benzopyrane; beta-naphthol methyl ether; ambroxane; dodecahydro-3a,6,6,9a-tetra-

methylnaphtho[2,1b]furan; cedrol, 5-(2,2,3-trimethylcyclopent-3-enyl)-3-methylpentan-2-ol; 2-ethyl-4-(2,2,3-trimethyl-3-cyclopenten-1-yl)-2-buten-1-ol; caryophyllene alcohol; tricyclodecenyl propionate; tricyclodecenyl acetate; benzyl salicylate; cedryl acetate; and para-(tert-butyl) cyclohexyl acetate.

Particularly preferred perfume materials are those that provide the largest odor improvements in finished product compositions containing cellulases. These perfumes include but are not limited to: hexyl cinnamic aldehyde; 2-methyl-3-(para-tert-butylphenyl)-propionaldehyde; 7-acetyl-1,2,3,4,5,6,7,8-octahydro-1,1,6,7-tetramethyl naphthalene; benzyl salicylate; 7-acetyl-1,1,3,4,4,6-hexamethyl tetralin; para-tert-butyl cyclohexyl acetate; methyl dihydro jasmonate; beta-naphthol methyl ether; methyl beta-naphthyl ketone; 2-methyl-2-(para-iso-propylphenyl)-propionaldehyde; 1,3,4,6,7,8-hexahydro-4,6,6,7,8,8-hexamethyl-cyclopentagamma-2-benzopyrane; dodecahydro-3a,6,6,9a-tetramethylnaphtho[2,1b]furan; anisaldehyde; coumarin; cedrol; vanillin; cyclopentadecanolide; tricyclodecenyl acetate; and tricyclodecenyl propionate.

Other perfume materials include essential oils, resinoids, and resins from a variety of sources including, but not limited to: Peru balsam, Olibanum resinoid, styrax, labdanum resin, nutmeg, cassia oil, benzoin resin, coriander and lavandin. Still other perfume chemicals include phenyl ethyl alcohol, terpineol, linalool, linalyl acetate, geraniol, nerol, 2-(1,1-dimethylethyl)-cyclohexanol acetate, benzyl acetate, and eugenol. Carriers such as diethylphthalate can be used in the finished perfume compositions.

Other Ingredients - A wide variety of other ingredients useful in detergent compositions can be included in the compositions herein, including other active ingredients, carriers, hydrotropes, processing aids, dyes or pigments, solvents for liquid formulations, solid fillers for bar compositions, etc. If high sudsing is desired, suds boosters such as the C₁₀-C₁₆ alkanolamides can be incorporated into the compositions, typically at 1%-10% levels. The C₁₀-C₁₄ monoethanol and diethanol amides illustrate a typical class of such suds boosters. Use of such suds boosters with high sudsing adjunct surfactants such as the amine oxides, betaines and sultaines noted above is also advantageous. If desired, water-soluble magnesium and/or calcium salts such as MgCl₂, MgSO₄, CaCl₂, CaSO₄ and the like, can be added at levels of, typically, 0.1%-2%, to provide additional suds and to enhance grease removal performance.

Various deterative ingredients employed in the present compositions optionally can be further stabilized by absorbing said ingredients onto a porous hydrophobic substrate, then coating said substrate with a hydrophobic coating.

Preferably, the deterative ingredient is admixed with a surfactant before being absorbed into the porous substrate. In use, the deterative ingredient is released from the substrate into the aqueous washing liquor, where it performs its intended deterative function.

To illustrate this technique in more detail, a porous hydrophobic silica (trademark SIPERNAT D10, DeGussa) is admixed with a proteolytic enzyme solution containing 3%-5% of C₁₃₋₁₅ ethoxylated alcohol (EO 7) nonionic surfactant. Typically, the enzyme/surfactant solution is 2.5 X the weight of silica. The resulting powder is dispersed with stirring in silicone oil (various silicone oil viscosities in the range of 500-12,500 can be used). The resulting silicone oil dispersion is emulsified or otherwise added to the final detergent matrix. By this means, ingredients such as the aforementioned enzymes, bleaches, bleach activators, bleach catalysts, photoactivators, dyes, fluorescers, fabric conditioners and hydrolyzable surfactants can be "protected" for use in detergents, including liquid laundry detergent compositions.

Liquid detergent compositions can contain water and other solvents as carriers. Low molecular weight primary or secondary alcohols exemplified by methanol, ethanol, propanol, and isopropanol are suitable. Monohydric alcohols are preferred for solubilizing surfactant, but polyols such as those containing from 2 to about 6 carbon atoms and from 2 to about 6 hydroxy groups (e.g., 1,3-propanediol, ethylene glycol, glycerine, and 1,2-propanediol) can also be used. The compositions may contain from 5% to 90%, typically 10% to 50% of such carriers.

The detergent compositions herein will preferably be formulated such that, during use in aqueous cleaning operations, the wash water will have a pH of between about 6.5 and about 11, preferably between about 7.5 and 10.5. Liquid dishwashing product formulations preferably have a pH between about 6.8 and about 9.0. Laundry products are typically at pH 9-11. Techniques for controlling pH at recommended usage levels include the use of buffers, alkalis, acids, etc., and are well known to those skilled in the art.

Form of the compositions

The compositions in accordance with the invention can take a variety of physical forms including granular, tablet, bar and liquid forms. The compositions are particularly the so-called concentrated granular detergent compositions adapted to be added to a washing machine by means of a dispensing device placed in the machine drum with the soiled fabric load.

The mean particle size of the components of granular compositions in accordance with the invention should preferably be such that no more than 5% of

particles are greater than 1.7mm in diameter and not more than 5% of particles are less than 0.15mm in diameter.

The term mean particle size as defined herein is calculated by sieving a sample of the composition into a number of fractions (typically 5 fractions) on a series of Tyler sieves. The weight fractions thereby obtained are plotted against the aperture size of the sieves. The mean particle size is taken to be the aperture size through which 50% by weight of the sample would pass.

The bulk density of granular detergent compositions in accordance with the present invention typically have a bulk density of at least 600 g/litre, more preferably from 650 g/litre to 1200 g/litre. Bulk density is measured by means of a simple funnel and cup device consisting of a conical funnel moulded rigidly on a base and provided with a flap valve at its lower extremity to allow the contents of the funnel to be emptied into an axially aligned cylindrical cup disposed below the funnel. The funnel is 130 mm high and has internal diameters of 130 mm and 40 mm at its respective upper and lower extremities. It is mounted so that the lower extremity is 140 mm above the upper surface of the base. The cup has an overall height of 90 mm, an internal height of 87 mm and an internal diameter of 84 mm. Its nominal volume is 500 ml.

To carry out a measurement, the funnel is filled with powder by hand pouring, the flap valve is opened and powder allowed to overfill the cup. The filled cup is removed from the frame and excess powder removed from the cup by passing a straight edged implement eg; a knife, across its upper edge. The filled cup is then weighed and the value obtained for the weight of powder doubled to provide a bulk density in g/litre. Replicate measurements are made as required.

Agglomerate particles

The cleaning systems herein are preferably present in granular compositions in the form of agglomerate particles, which may take the form of flakes, prills, marumes, noodles, ribbons, but preferably take the form of granules. The most preferred way to process the particles is by agglomerating powders (e.g. aluminosilicate, carbonate) with high level of surfactant pastes and to control the particle size of the resultant agglomerates within specified limits. Such a process involves mixing an effective amount of powder with a high surfactant active paste in one or more agglomerators such as a pan agglomerator, a Z-blade mixer or more preferably an in-line mixer such as those manufactured by Schugi (Holland) BV, 29 Chroomstraat 8211 AS, Lelystad, Netherlands, and Gebruder Lodige Maschinenbau GmbH, D-4790 Paderborn 1, Elsenerstrasse 7-9, Postfach 2050, Germany. Most preferably a high shear mixer is used, such as a Lodige CB (Trade Name).

- A high surfactant active paste comprising from 50% by weight to 95% by weight, preferably 70% by weight to 85% by weight of surfactant is typically used. The paste may be pumped into the agglomerator at a temperature high enough to maintain a pumpable viscosity, but low enough to avoid degradation of the surfactants used. An operating temperature of the paste of 50°C to 80°C is typical.

Laundry washing method

Machine laundry methods herein typically comprise treating soiled laundry with an aqueous wash solution in a washing machine having dissolved or dispensed therein an effective amount of a machine laundry detergent composition in accord with the invention. By an effective amount of the detergent composition it is meant from 40g to 300g of product dissolved or dispersed in a wash solution of volume from 5 to 65 litres, as are typical product dosages and wash solution volumes commonly employed in conventional machine laundry methods.

As noted, the isopeptidase enzyme is used herein in cleaning compositions, preferably in combination with deterative surfactants, at levels which are effective for achieving at least a directional improvement in cleaning performance. In the context of a fabric laundry composition, such "usage levels" can vary depending not only on the type and severity of the soils and stains, but also on the wash water temperature, the volume of wash water and the type of washing machine.

For example, in a top-loading, vertical axis U.S.-type automatic washing machine using about 45 to 83 liters of water in the wash bath, a wash cycle of about 10 to about 14 minutes and a wash water temperature of about 10°C to about 50°C, it is preferred to include from about 2 ppm to about 625 ppm, preferably from about 2 ppm to about 550 ppm, more preferably from about 10 ppm to about 235 ppm, of surfactant in the wash liquor. On the basis of usage rates of from about 50 ml to about 150 ml per wash load, this translates into an in-product concentration (wt.) of the surfactant of from about 0.1% to about 40%, preferably about 0.1% to about 35%, more preferably from about 0.5% to about 15%, for a heavy-duty liquid laundry detergent. On the basis of usage rates of from about 30g to about 950g per wash load, for dense ("compact") granular laundry detergents (density above about 650 g/l) this translates into an in-product concentration (wt.) of the surfactant of from about 0.1% to about 50%, preferably from about 0.1% to about 35%, and more preferably from about 0.5% to about 15%. On the basis of usage rates of from about 80 g to about 100 g per load for spray-dried granules (i.e., "fluffy"; density below about 650 g/l), this translates into an in-product concentration (wt.) of the surfactant of from about 0.07% to about 35%, preferably from about 0.07 to about 25%, and more preferably from about 0.35% to about 11%.

For example, in a front-loading, horizontal-axis European-type automatic washing machine using about 8 to 15 liters of water in the wash bath, a wash cycle of about 10 to about 60 minutes and a wash water temperature of about 30°C to about 95°C, it is preferred to include from about 3 ppm to about 14,000 ppm, preferably from about 3 ppm to about 10,000 ppm, more preferably from about 15

ppm to about 4200 ppm. of surfactant in the wash liquor. On the basis of usage rates of from about 45 ml to about 270 ml per wash load, this translates into an in-product concentration (wt.) of surfactant of from about 0.1% to about 50%, preferably about 0.1% to about 35%, more preferably from about 0.5% to about 15%, for a heavy-duty liquid laundry detergent. On the basis of usage rates of from about 40 g to about 210 g per wash load, for dense ("compact") granular laundry detergents (density above about 650 g/l) this translates into an in-product concentration (wt.) of surfactant of from about 0.12% to about 53%, preferably from about 0.12% to about 46%, and more preferably from about 0.6% to about 20%. On the basis of usage rates of from about 140 g to about 400 g per load for spray-dried granules (i.e., "fluffy"; density below about 650 g/l), this translates into an in-product concentration (wt.) of surfactant of from about 0.03% to about 34%, preferably from about 0.03% to about 24%, and more preferably from about 0.15% to about 10%.

For example, in a top-loading, vertical-axis Japanese-type automatic washing machine using about 26 to 52 liters of water in the wash bath, a wash cycle of about 8 to about 15 minutes and a wash water temperature of about 5°C to about 25°C, it is preferred to include from about 0.67 ppm to about 270 ppm, preferably from about 0.67 ppm to about 236 ppm, more preferably from about 3.4 ppm to about 100 ppm, of surfactant in the wash liquor. On the basis of usage rates of from about 20 ml to about 30 ml per wash load, this translates into an in-product concentration (wt.) of surfactant of from about 0.1% to about 40%, preferably about 0.1% to about 35%, more preferably from about 0.5% to about 15%, for a heavy-duty liquid laundry detergent. On the basis of usage rates of from about 18 g to about 35 g per wash load, for dense ("compact") granular laundry detergents (density above about 650 g/l) this translates into an in-product concentration (wt.) of surfactant of from about 0.1% to about 50%, preferably from about 0.1% to about 35%, and more preferably from about 0.5% to about 15%. On the basis of usage rates of from about 30 g to about 40 g per load for spray-dried granules (i.e., "fluffy"; density below about 650 g/l), this translates into an in-product concentration (wt.) of surfactant of from about 0.06% to about 44%, preferably from about 0.06% to about 30%, and more preferably from about 0.3% to about 13%.

As can be seen from the foregoing, the amount of isopeptidase enzyme used in a machine-wash laundering context can vary, depending on the habits and practices of the user, the type of washing machine, and the like. In this context, however, one heretofore unappreciated advantage of the isopeptidase enzymes is their ability to provide at least directional improvements in performance over a

spectrum of soils and stains even when used at relatively low levels in the finished compositions.

In a preferred use aspect a dispensing device is employed in the washing method. The dispensing device is charged with the detergent product, and is used to introduce the product directly into the drum of the washing machine before the commencement of the wash cycle. Its volume capacity should be such as to be able to contain sufficient detergent product as would normally be used in the washing method.

Once the washing machine has been loaded with laundry the dispensing device containing the detergent product is placed inside the drum. At the commencement of the wash cycle of the washing machine water is introduced into the drum and the drum periodically rotates. The design of the dispensing device should be such that it permits containment of the dry detergent product but then allows release of this product during the wash cycle in response to its agitation as the drum rotates and also as a result of its contact with the wash water.

To allow for release of the detergent product during the wash the device may possess a number of openings through which the product may pass. Alternatively, the device may be made of a material which is permeable to liquid but impermeable to the solid product, which will allow release of dissolved product. Preferably, the detergent product will be rapidly released at the start of the wash cycle thereby providing transient localised high concentrations of product in the drum of the washing machine at this stage of the wash cycle.

Preferred dispensing devices are reusable and are designed in such a way that container integrity is maintained in both the dry state and during the wash cycle. Especially preferred dispensing devices for use with the composition of the invention have been described in the following patents; GB-B-2, 157, 717, GB-B-2, 157, 718, EP-A-0201376, EP-A-0288345 and EP-A-0288346. An article by J.Bland published in *Manufacturing Chemist*, November 1989, pages 41-46 also describes especially preferred dispensing devices for use with granular laundry products which are of a type commonly known as the "granulette". Another preferred dispensing device for use with the compositions of this invention is disclosed in PCT Patent Application No. WO94/11562.

Especially preferred dispensing devices are disclosed in European Patent Application Publication Nos. 0343069 & 0343070. The latter Application discloses a device comprising a flexible sheath in the form of a bag extending from a support ring defining an orifice, the orifice being adapted to admit to the bag sufficient product for one washing cycle in a washing process. A portion of the washing

medium flows through the orifice into the bag, dissolves the product, and the solution then passes outwardly through the orifice into the washing medium. The support ring is provided with a masking arrangement to prevent egress of wetted, undissolved, product, this arrangement typically comprising radially extending walls extending from a central boss in a spoked wheel configuration, or a similar structure in which the walls have a helical form.

Alternatively, the dispensing device may be a flexible container, such as a bag or pouch. The bag may be of fibrous construction coated with a water impermeable protective material so as to retain the contents, such as is disclosed in European published Patent Application No. 0018678. Alternatively it may be formed of a water-insoluble synthetic polymeric material provided with an edge seal or closure designed to rupture in aqueous media as disclosed in European published Patent Application Nos. 0011500, 0011501, 0011502, and 0011968. A convenient form of water frangible closure comprises a water soluble adhesive disposed along and sealing one edge of a pouch formed of a water impermeable polymeric film such as polyethylene or polypropylene.

Preferably, the liquid compositions according to the present invention are in "concentrated form"; in such case, the liquid detergent compositions according to the present invention will contain a lower amount of water, compared to conventional liquid detergents. The level of water is less than 50%, preferably less than 30% by weight of the detergent compositions.

Said concentrated products provide advantages to the consumer, who has a product which can be used in lower amounts and to the producer, who has lower shipping costs.

The liquid compositions are especially effective when applied directly to soils and stains in a pretreatment step before washing the fabrics.

The detergent compositions of the present invention can also be used as detergent additive products. Such additive products are intended to supplement or boost the performance of conventional detergent compositions.

The detergent compositions according to the present invention include compositions which are to be used for cleaning of substrates, such as fabrics, fibers, hard surfaces, etc., for example hard surface cleaning compositions (with or without abrasives), laundry detergent compositions, automatic and non-automatic dishwashing compositions.

Packaging for the compositions

Commercially marketed executions of the bleaching compositions can be packaged in any suitable container including those constructed from paper,

cardboard, plastic materials and any suitable laminates. A preferred packaging execution is described in European Application No. 94921505.7.

In the following Examples, the abbreviations for the various ingredients used for the compositions have the following meanings.

LAS	:	Sodium linear C ₁₂ alkyl benzene sulfonate
Isopeptidase	:	Isopeptidase enzyme known as "destabilase" (SEQ ID No. 7)
C45AS	:	Sodium C ₁₄ -C ₁₅ linear alkyl sulfate
CxyEzS	:	Sodium C _{1x} -C _{1y} branched alkyl sulfate condensed with z moles of ethylene oxide
CxyEz	:	A C _{1x-1y} branched primary alcohol condensed with an average of z moles of ethylene oxide
QAS	:	R ₂ .N ⁺ (CH ₃) ₂ (C ₂ H ₄ OH) with R ₂ = C ₁₂ - C ₁₄
TFAA	:	C ₁₆ -C ₁₈ alkyl N-methyl glucamide
STPP	:	Anhydrous sodium tripolyphosphate
Zeolite A	:	Hydrated Sodium Aluminosilicate of formula Na ₁₂ (Al ₁₀ Si ₂ O ₂) ₁₂ . 27H ₂ O having a primary particle size in the range from 0.1 to 10 micrometers
NaSKS-6	:	Crystalline layered silicate of formula δ -Na ₂ Si ₂ O ₅
Carbonate	:	Anhydrous sodium carbonate with a particle size between 200μm and 900μm
Bicarbonate	:	Anhydrous sodium bicarbonate with a particle size distribution between 400μm and 1200μm
Silicate	:	Amorphous Sodium Silicate (SiO ₂ :Na ₂ O; 2.0 ratio)
Sodium sulfate	:	Anhydrous sodium sulfate
MA/AA	:	Copolymer of 1:4 maleic/acrylic acid, average molecular weight about 70,000.
CMC	:	Sodium carboxymethyl cellulose
Protease	:	Proteolytic enzyme of activity 4KNPU/g sold by NOVO Industries A/S under the tradename Savinase

- Cellulase	:	Cellulytic enzyme of activity 1000 CEVU/g sold by NOVO Industries A/S under the tradename Carezyme
Amylase	:	Amylolytic enzyme of activity 60KNU/g sold by NOVO Industries A/S under the tradename Termamyl 60T
Lipase	:	Lipolytic enzyme of activity 100kLU/g sold by NOVO Industries A/S under the tradename Lipolase
PB4	:	Sodium perborate tetrahydrate of nominal formula $\text{NaBO}_2 \cdot 3\text{H}_2\text{O} \cdot \text{H}_2\text{O}_2$
PB1	:	Anhydrous sodium perborate bleach of nominal formula $\text{NaBO}_2 \cdot \text{H}_2\text{O}_2$
Percarbonate	:	Sodium Percarbonate of nominal formula $2\text{Na}_2\text{CO}_3 \cdot 3\text{H}_2\text{O}_2$
NaDCC	:	Sodium dichloroisocyanurate
NOBS	:	Nonanoyloxybenzene sulfonate in the form of the sodium salt.
TAED	:	Tetraacetythylenediamine
DTPMP phosphonate),	:	Diethylene triamine penta (methylene marketed by Monsanto under the Trade name Dequest 2060
Photoactivated bleach	:	Sulfonated Zinc Phthlocyanine encapsulated in dextrin soluble polymer
Brightener 1	:	Disodium 4,4'-bis(2-sulphostyryl)biphenyl
Brightener 2	:	Disodium 4,4'-bis(4-anilino-6-morpholino-1.3.5-triazin-2-yl)amino) stilbene-2:2'-disulfonate.
HEDP	:	1,1-hydroxyethane diphosphonic acid
SRP 1	:	Sulfobenzoyl end capped esters with oxyethylene oxy and terephtaloyl backbone
Silicone antifoam :	:	Polydimethylsiloxane foam controller with siloxane-oxyalkylene copolymer as dispersing agent with a ratio of said foam controller to said dispersing agent of 10:1 to 100:1.
DTPA	:	Diethylene triamine pentaacetic acid

In the following Examples all levels are quoted as % by weight of the composition. The following examples are illustrative of the present invention, but are not meant to limit or otherwise define its scope. All parts, percentages and ratios used herein are expressed as percent weight unless otherwise specified.

Example 1

The following laundry detergent compositions A to F are prepared in accord with the invention. These compositions may be used in a machine or hand laundering process, including use as a pre-soak prior to a machine laundering process.

	A	B	C	D	E	F
Isopeptidase	0.26	0.26	0.26	0.26	0.26	0.26
C25E3	3.4	3.4	3.4	3.4	3.4	3.4
LAS	20	20	15	17	22	14
QAS	-	-	0.8	-	-	0.8
Zeolite A	18.1	18.1	18.1	18.1	18.1	18.1
Carbonate	13.0	13.0	13.0	27.0	27.0	27.0
Silicate	1.4	1.4	1.4	3.0	3.0	3.0
Sodium sulfate	26.1	26.1	26.1	26.1	26.1	26.1
PB4	---	---	---	9.0	9.0	9.0
TAED	---	---	---	1.5	1.5	1.5
DETPMP	0.25	0.25	0.25	0.25	0.25	0.25
HEDP	0.3	0.3	0.3	0.3	0.3	0.3

Protease	0.26	0.26	0.26	0.26	0.26	0.26
Amylase	0.1	0.1	0.1	0.1	0.1	0.1
MA/AA	0.3	0.3	0.3	0.3	0.3	0.3
CMC	0.2	0.2	0.2	0.2	0.2	0.2
Photoactivated bleach (ppm)	15 ppm	15 ppm	15 ppm	15 ppm	15 ppm	15 ppm
Brightener 1	0.09	0.09	0.09	0.09	0.09	0.09
Perfume	0.3	0.3	0.3	0.3	0.3	0.3
Silicone antifoam	0.5	0.5	0.5	0.5	0.5	0.5
Misc/minors to 100%						
Density in g/litre	850	850	850	850	850	850

Example 2

The following granular laundry detergent compositions G to I of bulk density 750 g/litre are prepared in accord with the invention:

	G	H	I
Isopeptidase	0.26	0.85	0.85
C45AS	-	2.24	3.89
C25AE3S	-	0.76	1.18
C45E7	3.25	-	5.0
C25E3	-	5.5	-
QAS	0.8	2.0	2.0
STPP	10.7	-	-
Zeolite A	10.7	19.5	19.5
SKS-6	-	10.6	10.6
Carbonate	6.1	21.4	21.4
Bicarbonate	-	2.0	2.0
Silicate	6.8	-	-
Sodium sulfate	39.8	-	14.3
PB4	5.0	12.7	8.0
TAED	0.5	3.1	-

DETPMP	0.25	0.2	0.2
HEDP	-	0.3	0.3
Protease	0.26	0.85	0.85
Lipase	0.15	0.15	0.15
Cellulase	0.28	0.28	0.28
Amylase	0.1	0.1	0.1
MA/AA	0.8	1.6	1.6
CMC	0.2	0.4	0.4
Photoactivated bleach (ppm)	15 ppm	27 ppm	27 ppm
Brightener 1	0.08	0.19	0.19
Brightener 2	-	0.04	0.04
Perfume	0.3	0.3	0.3
Silicone antifoam	0.5	2.4	2.4
Minors/misc to 100%			

Example 3

The following detergent formulations, according to the present invention are prepared:

	J	K	L	M
LAS	15.0	14.0	14.0	18.0
Isopeptidase	0.8	1.0	0.5	0.5
TFAA	-	1.0	-	-
C25E5/C45E7	-	2.0	-	0.5
C45E3S	-	2.5	-	-
Zeolite A	30.0	18.0	30.0	22.0
Silicate	9.0	5.0	10.0	8.0
Carbonate	13.0	7.5	-	5.0
Bicarbonate	-	7.5	-	-
DTPMP	0.7	1.0	-	-
SRP 1	0.3	0.2	-	0.1
MA/AA	2.0	1.5	2.0	1.0
CMC	0.8	0.4	0.4	0.2
Protease	0.8	1.0	0.5	0.5
Amylase	0.8	0.4	-	0.25
Lipase	0.2	0.1	0.2	0.1
Cellulase	0.15	0.05	-	-
Photoactivated bleach (ppm)	70ppm	45ppm	-	10ppm
Brightener 1	0.2	0.2	0.08	0.2
PB1	6.0	2.0	5.0	3.0
NOBS	2.0	1.0	-	-
Polyethylene oxide of MW 5,000,000	-	0.2	-	0.2
Bentonite clay	-	-	-	10.0
Balance (Moisture and Miscellaneous)	100	100	100	100

Example 4

The following high density detergent formulations, according to the present invention are prepared:

	N	O
Agglomerate		
C45AS	11.0	14.0
Isopeptidase	1.4	1.4
Zeolite A	15.0	10.0
Carbonate	4.0	8.0
MA/AA	4.0	2.0
CMC	0.5	0.5
DTPMP	0.4	0.4
Spray On		
C25E5	5.0	5.0
Perfume	0.5	0.5
Dry Adds		
C ₂₀ SADS	6.0	3.0
HEDP	0.5	0.3
SKS-6	13.0	6.0
Citrate	3.0	1.0
TAED	5.0	7.0
Percarbonate	20.0	20.0
SRP 1	0.3	0.3
Protease	1.4	1.4
Lipase	0.4	0.4
Cellulase	0.6	0.6
Amylase	0.6	0.6
Silicone antifoam	5.0	5.0
Brightener 1	0.2	0.2
Brightener 2	0.2	-
Balance (Moisture and Miscellaneous)	100	100
Density (g/litre)	850	850

EXAMPLE 5

Liquid detergent compositions are made according to the following.

% by weight of the detergent compositions

	A	B	C	D
C ₂₅ AE3S	2	8	7	5
Isopeptidase	0.5	0.5	0.5	0.5

C ₁₂ -C ₁₄ alkyldimethyl amine oxide	-	-	-	2
C ₂₅ AS	15	12	8	8
C ₂₄ N-methyl glucamide	5	4	3	3
C ₂₄ AE5	6	1	1	1
C ₁₂ -C ₁₈ fatty acid	11	4	4	3
Citric acid	1	3	3	2
DTPMP	1	1	1	0.5
MEA	8	5	5	2
NaOH	1	2.5	1	1.5
PG	14.5	13.1	10.0	8
EtOH	1.8	4.7	5.4	1
Amylase (300KNU/g)	0.1	0.1	0.1	0.1
Lipase D96/L (100KNU/g)	0.15	0.15	0.15	0.15
Protease (35g/l)	0.5	0.5	0.5	0.5)
Endolase	0.05	0.05	0.05	0.5
Cellulase	0.09	0.09	0.09	0.9
Terephthalate-based polymer	0.5	-	0.3	0.3
Boric acid	2.4	2.8	2.8	2.4
Sodium xylene sulfonate	-	3	-	-
2-butyl-octanol	1	1	1	1
Branched silicone	0.3	0.3	0.3	0.3
Water & minors	Up to 100%			

*SEASA is the isethionate ethoxylated ester of alpha-sulfonated C₁₆/C₁₈ fatty acid.

The above liquid detergent compositions (A-D) are found to be very efficient in the removal of a wide range of stains and soils from fabrics under various usage conditions.

EXAMPLES 6-11

The following are heavy duty liquid laundry detergent compositions according to the present invention.

<u>Example #:</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>	<u>11</u>
Isopeptidase	0.6	0.6	0.9	0.9	1.2	1.2
C ₂₅ AS	10	8.0	-	-	5.0	5.0
C ₃₅ AE3S/C ₂₅ AE3S	2.0	9.0	-	-	7.0	7.0
C ₂₄ N-Me Glucamide	6.0	5.0	4.5	3.7	4.0	4.0
C ₃₅ E7	6.0	1.0	-	-	-	-

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C25 AE2.5S	-	-	12.0	12.0	-	-
C23 E9	-	-	2.0	1.0	5.0	5.0
C10 APA	-	1.5	-	2.0	-	2.5
C24 Fatty Acid	7.5	1.1	2.0	4.0	5.0	5.0
C48 Fatty Acid	3.0	3.5	-	-	-	-
Citric Acid	1.0	3.5	3.0	3.0	3.0	3.0
Protease (34 g/#)	0.6	0.6	0.9	0.9	1.2	1.2
Lipase	0.1	0.1	0.1	0.1	0.2	0.2
Amylase (300KMU/g)	0.1	0.1	0.1	0.1	-	0.1
Cellulase	0.03	0.03	0.05	0.05	0.2	0.2
Endolase	0.1	0.1	-	-	-	-
Brightener 2	0.1	0.1	-	-	-	-
Boric Acid	3.0	3.0	3.5	3.5	4.0	4.0
MEA	8.0	4.0	1.0	1.5	7.0	7.0
NaOH	1.0	4.0	3.0	2.5	1.0	1.0
PG	12.0	12.0	7.5	7.5	7.0	7.0
EtOH	1.0	1.0	3.5	3.5	6.0	6.0
Na TS	-	-	2.5	2.5	-	-

Minors

-----Balance-----

The manufacture of heavy duty liquid detergent compositions, especially those designed for fabric laundering, which comprise a non-aqueous carrier medium can be conducted in the manner disclosed in more detail hereinafter. In an alternate mode, such non-aqueous compositions can be prepared according to the disclosures of U.S. Patents 4,753,570; 4,767,558; 4,772,413; 4,889,652; 4,892,673; GB-A-2,158,838; GB-A-2,195,125; GB-A-2,195,649; U.S. 4,988,462; U.S. 5,266,233; EP-A-225,654 (6/16/87); EP-A-510,762 (10/28/92); EP-A-540,089 (5/5/93); EP-A-540,090 (5/5/93); U.S. 4,615,820; EP-A-565,017 (10/13/93); EP-A-030,096 (6/10/81), incorporated herein by reference. Such compositions can contain various particulate deterative ingredients (including the bleaching agents, as disclosed hereinabove) stably suspended therein. Such non-aqueous compositions thus comprise a LIQUID PHASE and, optionally but preferably, a SOLID PHASE, all as described in more detail hereinafter and in the cited references. The isopeptidase enzyme is incorporated in the compositions at the levels and in the manner described hereinabove for the manufacture of other laundry detergent compositions.

LIQUID PHASE

The liquid phase will generally comprise from about 35% to 99% by weight of the detergent compositions herein. More preferably, the liquid phase will

comprise from about 50% to 95% by weight of the compositions. Most preferably, the liquid phase will comprise from about 45% to 75% by weight of the compositions herein. The liquid phase of the detergent compositions herein essentially contains relatively high concentrations of a certain type anionic surfactant combined with a certain type of nonaqueous, liquid diluent.

(A) Essential Anionic Surfactant

The anionic surfactant essentially utilized as an essential component of the nonaqueous liquid phase is one selected from the alkali metal salts of alkylbenzene sulfonic acids in which the alkyl group contains from about 10 to 16 carbon atoms, in straight chain or branched chain configuration. (See U.S. Patents 2,220,099 and 2,477,383, incorporated herein by reference.) Especially preferred are the sodium and potassium linear straight chain alkylbenzene sulfonates (LAS) in which the average number of carbon atoms in the alkyl group is from about 11 to 14. Sodium C₁₁-C₁₄ LAS is especially preferred.

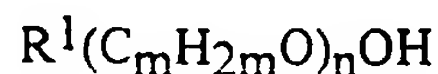
The alkylbenzene sulfonate anionic surfactant will be dissolved in the nonaqueous liquid diluent which makes up the second essential component of the nonaqueous phase. To form the structured liquid phase required for suitable phase stability and acceptable rheology, the alkylbenzene sulfonate anionic surfactant is generally present to the extent of from about 30% to 65% by weight of the liquid phase. More preferably, the alkylbenzene sulfonate anionic surfactant will comprise from about 35% to 50% by weight of the nonaqueous liquid phase of the compositions herein. Utilization of this anionic surfactant in these concentrations corresponds to an anionic surfactant concentration in the total composition of from about 15% to 60% by weight, more preferably from about 20% to 40% by weight, of the composition.

(B) Nonaqueous Liquid Diluent

To form the liquid phase of the detergent compositions, the hereinbefore described alkylbenzene sulfonate anionic surfactant is combined with a nonaqueous liquid diluent which contains two essential components. These two components are a liquid alcohol alkoxylate material and a nonaqueous, low-polarity organic solvent.

i) Alcohol Alkoxylates

One essential component of the liquid diluent used to form the compositions herein comprises an alkoxylated fatty alcohol material. Such materials are themselves also nonionic surfactants. Such materials correspond to the general formula:



wherein R^1 is a $C_8 - C_{16}$ alkyl group. m is from 2 to 4, and n ranges from about 2 to 12. Preferably R^1 is an alkyl group, which may be primary or secondary, that contains from about 9 to 15 carbon atoms, more preferably from about 10 to 14 carbon atoms. Preferably also the alkoxyated fatty alcohols will be ethoxylated materials that contain from about 2 to 12 ethylene oxide moieties per molecule, more preferably from about 3 to 10 ethylene oxide moieties per molecule.

The alkoxyated fatty alcohol component of the liquid diluent will frequently have a hydrophilic-lipophilic balance (HLB) which ranges from about 3 to 17. More preferably, the HLB of this material will range from about 6 to 15, most preferably from about 8 to 15.

Examples of fatty alcohol alkoxyates useful as one of the essential components of the nonaqueous liquid diluent in the compositions herein will include those which are made from alcohols of 12 to 15 carbon atoms and which contain about 7 moles of ethylene oxide. Such materials have been commercially marketed under the trade names Neodol 25-7 and Neodol 23-6.5 by Shell Chemical Company. Other useful Neodols include Neodol 1-5, an ethoxylated fatty alcohol averaging 11 carbon atoms in its alkyl chain with about 5 moles of ethylene oxide; Neodol 23-9, an ethoxylated primary $C_{12} - C_{13}$ alcohol having about 9 moles of ethylene oxide and Neodol 91-10, an ethoxylated $C_9 - C_{11}$ primary alcohol having about 10 moles of ethylene oxide. Alcohol ethoxyates of this type have also been marketed by Shell Chemical Company under the Dobanol tradename. Dobanol 91-5 is an ethoxylated $C_9 - C_{11}$ fatty alcohol with an average of 5 moles ethylene oxide and Dobanol 25-7 is an ethoxylated $C_{12} - C_{15}$ fatty alcohol with an average of 7 moles of ethylene oxide per mole of fatty alcohol.

Other examples of suitable ethoxylated alcohols include Tergitol 15-S-7 and Tergitol 15-S-9 both of which are linear secondary alcohol ethoxyates that have been commercially marketed by Union Carbide Corporation. The former is a mixed ethoxylation product of C_{11} to C_{15} linear secondary alkanol with 7 moles of ethylene oxide and the latter is a similar product but with 9 moles of ethylene oxide being reacted.

Other types of alcohol ethoxyates useful in the present compositions are higher molecular weight nonionics, such as Neodol 45-11, which are similar ethylene oxide condensation products of higher fatty alcohols, with the higher fatty alcohol being of 14-15 carbon atoms and the number of ethylene oxide groups per mole being about 11. Such products have also been commercially marketed by Shell Chemical Company.

The alcohol alkoxylate component which is essentially utilized as part of the liquid diluent in the nonaqueous compositions herein will generally be present to the extent of from about 1% to 60% of the liquid phase composition. More preferably, the alcohol alkoxylate component will comprise about 5% to 40% of the liquid phase. Most preferably, the essentially utilized alcohol alkoxylate component will comprise from about 5% to 30% of the detergent composition liquid phase. Utilization of alcohol alkoxylate in these concentrations in the liquid phase corresponds to an alcohol alkoxylate concentration in the total composition of from about 1% to 60% by weight, more preferably from about 2% to 40% by weight, and most preferably from about 5% to 25% by weight, of the composition.

ii) Nonaqueous Low-Polarity Organic Solvent

A second essential component of the liquid diluent which forms part of the liquid phase of the detergent compositions herein comprises nonaqueous, low-polarity organic solvent(s). The term "solvent" is used herein to connote the non-surface active carrier or diluent portion of the liquid phase of the composition. While some of the essential and/or optional components of the compositions herein may actually dissolve in the "solvent"-containing liquid phase, other components will be present as particulate material dispersed within the "solvent"-containing liquid phase. Thus the term "solvent" is not meant to require that the solvent material be capable of actually dissolving all of the detergent composition components added thereto.

The nonaqueous organic materials which are employed as solvents herein are those which are liquids of low polarity. For purposes of this invention, "low-polarity" liquids are those which have little, if any, tendency to dissolve one of the preferred types of particulate material used in the compositions herein, i.e., the peroxygen bleaching agents, sodium perborate or sodium percarbonate. Thus relatively polar solvents such as ethanol should not be utilized. Suitable types of low-polarity solvents useful in the nonaqueous liquid detergent compositions herein do include non-vicinal C₄-C₈ alkylene glycols, alkylene glycol mono lower alkyl ethers, lower molecular weight polyethylene glycols, lower molecular weight methyl esters and amides, and the like.

A preferred type of nonaqueous, low-polarity solvent for use in the compositions herein comprises the non-vicinal C₄-C₈ branched or straight chain alkylene glycols. Materials of this type include hexylene glycol (4-methyl-2,4-pentanediol), 1,6-hexanediol, 1,3-butylene glycol and 1,4-butylene glycol. Hexylene glycol is the most preferred.

Another preferred type of nonaqueous, low-polarity solvent for use herein comprises the mono-, di-, tri-, or tetra- C₂-C₃ alkylene glycol mono C₂-C₆ alkyl ethers. The specific examples of such compounds include diethylene glycol monobutyl ether, tetraethylene glycol monobutyl ether, dipropylene glycol monoethyl ether, and dipropylene glycol monobutyl ether. Diethylene glycol monobutyl ether and dipropylene glycol monobutyl ether are especially preferred. Compounds of the type have been commercially marketed under the tradenames Dowanol, Carbitol, and Cellosolve.

Another preferred type of nonaqueous, low-polarity organic solvent useful herein comprises the lower molecular weight polyethylene glycols (PEGs). Such materials are those having molecular weights of at least about 150. PEGs of molecular weight ranging from about 200 to 600 are most preferred.

Yet another preferred type of non-polar, nonaqueous solvent comprises lower molecular weight methyl esters. Such materials are those of the general formula: R¹-C(O)-OCH₃ wherein R¹ ranges from 1 to about 18. Examples of suitable lower molecular weight methyl esters include methyl acetate, methyl propionate, methyl octanoate, and methyl dodecanoate.

The nonaqueous, low-polarity organic solvent(s) employed should, of course, be compatible and non-reactive with other composition components, e.g., bleach and/or activators, used in the liquid detergent compositions herein. Such a solvent component will generally be utilized in an amount of from about 1% to 70% by weight of the liquid phase. More preferably, the nonaqueous, low-polarity organic solvent will comprise from about 10% to 60% by weight of the liquid phase, most preferably from about 20% to 50% by weight, of the liquid phase of the composition. Utilization of this organic solvent in these concentrations in the liquid phase corresponds to a solvent concentration in the total composition of from about 1% to 50% by weight, more preferably from about 5% to 40% by weight, and most preferably from about 10% to 30% by weight, of the composition.

iii) Alcohol Alkoxylate To Solvent Ratio

The ratio of alcohol alkoxylate to organic solvent within the liquid diluent can be used to vary the rheological properties of the detergent compositions eventually formed. Generally, the weight ratio of alcohol alkoxylate to organic solvent will range from about 50:1 to 1:50. More preferably, this ratio will range from about 3:1 to 1:3.

iv) Liquid Diluent Concentration

As with the concentration of the alkylbenzene sulfonate anionic surfactant mixture, the amount of total liquid diluent in the nonaqueous liquid phase herein will

be determined by the type and amounts of other composition components and by the desired composition properties. Generally, the liquid diluent will comprise from about 35% to 70% of the nonaqueous liquid phase of the compositions herein. More preferably, the liquid diluent will comprise from about 50% to 65% of the nonaqueous liquid phase. This corresponds to a nonaqueous liquid diluent concentration in the total composition of from about 15% to 70% by weight, more preferably from about 20% to 50% by weight, of the composition.

SOLID PHASE

The nonaqueous detergent compositions herein also essentially comprise from about 1% to 65% by weight, more preferably from about 5% to 50% by weight, of a solid phase of particulate material which is dispersed and suspended within the liquid phase. Generally such particulate material will range in size from about 0.1 to 1500 microns. More preferably such material will range in size from about 5 to 200 microns.

The particulate material utilized herein can comprise one or more types of detergent composition components which in particulate form are substantially insoluble in the nonaqueous liquid phase of the composition. The types of particulate materials which can be utilized are described in detail as follows:

COMPOSITION PREPARATION AND USE

The nonaqueous liquid detergent compositions herein can be prepared by combining the essential and optional components thereof in any convenient order and by mixing, e.g., agitating, the resulting component combination to form the phase stable compositions herein. In a typical process for preparing such compositions, essential and certain preferred optional components will be combined in a particular order and under certain conditions.

In the first step of such a typical preparation process, an admixture of the alkylbenzene sulfonate anionic surfactant and the two essential components of the nonaqueous diluent is formed by heating a combination of these materials to a temperature from about 30°C to 100°C.

In a second process step, the heated admixture formed as hereinbefore described is maintained under shear agitation at a temperature from about 40°C to 100°C for a period of from about 2 minutes to 20 hours. Optionally, a vacuum can be applied to the admixture at this point. This second process step serves to completely dissolve the anionic surfactant in the nonaqueous liquid phase.

In a third process step, this liquid phase combination of materials is cooled to a temperature of from about 0°C to 35°C. This cooling step serves to form a

structured. surfactant-containing liquid base into which the particulate material of the detergent compositions herein can be added and dispersed.

Particulate material is added in a fourth process step by combining the particulate material with the liquid base which is maintained under conditions of shear agitation. When more than one type of particulate material is to be added, it is preferred that a certain order of addition be observed. For example, while shear agitation is maintained, essentially all of any optional surfactants in solid particulate form can be added in the form of particles ranging in size from about 0.2 to 1,000 microns. After addition of any optional surfactant particles, particles of substantially all of an organic builder, e.g., citrate and/or fatty acid, and/or an alkalinity source, e.g., sodium carbonate, can be added while continuing to maintain this admixture of composition components under shear agitation. Other solid form optional ingredients can then be added to the composition at this point. Agitation of the mixture is continued, and if necessary, can be increased at this point to form a uniform dispersion of insoluble solid phase particulates within the liquid phase.

After some or all of the foregoing solid materials have been added to this agitated mixture, the particles of the bleaching agent can be added to the composition, again while the mixture is maintained under shear agitation. By adding the bleaching agent material last, or after all or most of the other components, and especially after alkalinity source particles, have been added, desirable stability benefits for the bleach can be realized. If enzyme prills are incorporated, they are preferably added to the nonaqueous liquid matrix last.

As a final process step, after addition of all of the particulate material, agitation of the mixture is continued for a period of time sufficient to form compositions having the requisite viscosity and phase stability characteristics. Frequently this will involve agitation for a period of from about 1 to 30 minutes.

As a variation of the composition preparation procedure hereinbefore described, one or more of the solid components may be added to the agitated mixture as a slurry of particles premixed with a minor portion of one or more of the liquid components. Thus a premix of a small fraction of the alcohol alkoxylate and/or nonaqueous, low-polarity solvent with particles of the organic builder material and/or the particles of the inorganic alkalinity source and/or particles of a bleach activator may be separately formed and added as a slurry to the agitated mixture of composition components. Addition of such slurry premixes should precede addition of bleaching agent and/or enzyme particles which may themselves be part of a premix slurry formed in analogous fashion.

The compositions of this invention, prepared as hereinbefore described, can be used to form aqueous washing solutions for use in the laundering and bleaching of fabrics. Generally, an effective amount of such compositions is added to water, preferably in a conventional fabric laundering automatic washing machine, to form such aqueous laundering/bleaching solutions. The aqueous washing/bleaching solution so formed is then contacted, preferably under agitation, with the fabrics to be laundered and bleached therewith.

An effective amount of the liquid detergent compositions herein added to water to form aqueous laundering/bleaching solutions can comprise amounts sufficient to form from about 500 to 7,000 ppm of composition in aqueous solution. More preferably, from about 800 to 3,000 ppm of the detergent compositions herein will be provided in aqueous washing/bleaching solution.

EXAMPLE 12

A non-limiting example of bleach-containing nonaqueous liquid laundry detergent is prepared having the composition as set forth in Table I.

Table I

<u>Component</u>	<u>Wt. %</u>	<u>Range (% wt.)</u>
<u>Liquid Phase</u>		
Na C ₁₂ Linear alkylbenzene sulfonate (LAS)	25.3	18-35
Isopeptidase	0.4	0.01-1
C ₁₂₋₁₄ , EO5 alcohol ethoxylate	13.6	10-20
Hexylene glycol	27.3	20-30
Perfume	0.4	0-1.0
<u>Solids</u>		
Protease enzyme	0.4	0-1.0
Na ₃ Citrate, anhydrous	4.3	3-6
Sodium perborate	3.4	2-7
Sodium nonanoyloxybenzene sulfonate (NOBS)	8.0	2-12
Sodium carbonate	13.9	5-20
Diethyl triamine pentaacetic acid (DTPA)	0.9	0-1.5
Brightener	0.4	0-0.6
Suds Suppressor	0.1	0-0.3
Minors	Balance	----

The resulting composition is a stable anhydrous heavy duty liquid laundry detergent which provides excellent stain and soil removal performance when used in normal fabric laundering operations.

The following Example further illustrates the invention herein with respect to a hand dishwashing liquid.

EXAMPLE 13

<u>Ingredient</u>	<u>% (wt.)</u>	<u>Range (% wt.)</u>
Isopeptidase	0.5	0.01-1
Ammonium C ₁₂₋₁₃ alkyl sulfate	7.0	2-35
C _{12-C₁₄} ethoxy (1) sulfate	20.5	5-35
Coconut amine oxide	2.6	2-5
Betaine/Tetronic 704®**	0.87-0.10	0-2 (mix)
Alcohol Ethoxylate C ₈ E ₁₁	5.0	2-10
Ammonium xylene sulfonate	4.0	1-6
Ethanol	4.0	0-7
Ammonium citrate	0.06	0-1.0
Magnesium chloride	3.3	0-4.0
Calcium chloride	2.5	0-4.0
Ammonium sulfate	0.08	0-4.0
Hydrogen peroxide	200 ppm	10-300 ppm
Perfume	0.18	0-0.5
Maxatase® protease	0.50	0-1.0
Water and minors	-----Balance-----	

**Cocoalkyl betaine.

SEQUENCE LISTING

(1) INFORMATION FOR SEQ ID NO:1:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 557 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: DNA (genomic)

(iii) SEQUENCE DESCRIPTION: SEQ ID NO:1:

GAACTGGCAA	TCTTAATATC	TCACTA	ATG AAT TAC GTT ATC TTT GTG GTC TTA		53
			Met Asn Tyr Val Ile Phe Val Val Leu		
		1		5	
GTG GCA CTT TAC GTC ATC GAG GTA GCG AAG TGC ACC GTC CCA TCC GAT					101
Val Ala Leu Tyr Val Ile Glu Val Ala Lys Cys Thr Val Pro Ser Asp					
10		15		20	25
TGC TTG AGG TGC ATT TGC CAG GTA GAG GGA TGT AAC AAT GAG ATT GGA					149
Cys Leu Arg Cys Ile Cys Gln Val Glu Gly Cys Asn Asn Glu Ile Gly					
	30		35		40
AGG TGC GGC ATG GAC GCA GGA AGT CTG AGC TGT GGT CCT TAC CAG ATC					197
Arg Cys Gly Met Asp Ala Gly Ser Leu Ser Cys Gly Pro Tyr Gln Ile					
	45		50		55
AAG GAG CCC TAC AGG ATT GAC TGT GGA AGG CCA GGA GGA GGA TAC CAG					245
Lys Glu Pro Tyr Arg Ile Asp Cys Gly Arg Pro Gly Gly Gly Tyr Gln					
	60		65		70
CAG TGC ACG AAG GAG AAG GCA TGT TCT GAA AGG TGT GTC CAC GCT TAC					293
Gln Cys Thr Lys Glu Lys Ala Cys Ser Glu Arg Cys Val His Ala Tyr					
	75		80		85
ATG GAC AGG TAT GCC AGA AGG TGT ACT GGA GGA CGC CAA CCG ACC TGC					341
Met Asp Arg Tyr Ala Arg Arg Cys Thr Gly Gly Arg Gln Pro Thr Cys					
	90		95		100
CAA GAC TAC GCC AAA ATT CAC AAC ATG GGA CCG AAC GGA TGC CAA TCT					389
Gln Asp Tyr Ala Lys Ile His Asn Met Gly Pro Asn Gly Cys Gln Ser					
	110		115		120
TCA AAC AAC CAC TAC TGG GAT AAT GTC AGG AGA TGT TTG GGC TGA					434
Ser Asn Asn His Tyr Trp Asp Asn Val Arg Arg Cys Leu Gly *					
	125		130		135
AGAAAGAAGG AGGAACAACA TTGCCTCAAG GTCGGCCATT TTAAAGATGG CTGCTGTTGA					494
TGTATCAAAT TCTAAATTAA AGAAAAGNCA TTTTTAAATT GAATAAATAC CAAATGATAA					554
ATG					557

(2) INFORMATION FOR SEQ ID NO:2:

81

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 136 amino acids
 (B) TYPE: amino acid
 (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

(iii) SEQUENCE DESCRIPTION: SEQ ID NO:2:

```

Met Asn Tyr Val Ile Phe Val Val Leu Val Ala Leu Tyr Val Ile Glu
 1             5             10             15
Val Ala Lys Cys Thr Val Pro Ser Asp Cys Leu Arg Cys Ile Cys Gln
          20             25             30
Val Glu Gly Cys Asn Asn Glu Ile Gly Arg Cys Gly Met Asp Ala Gly
          35             40             45
Ser Leu Ser Cys Gly Pro Tyr Gln Ile Lys Glu Pro Tyr Arg Ile Asp
          50             55             60
Cys Gly Arg Pro Gly Gly Gly Tyr Gln Gln Cys Thr Lys Glu Lys Ala
          65             70             75             80
Cys Ser Glu Arg Cys Val His Ala Tyr Met Asp Arg Tyr Ala Arg Arg
          85             90             95
Cys Thr Gly Gly Arg Gln Pro Thr Cys Gln Asp Tyr Ala Lys Ile His
          100            105            110
Asn Met Gly Pro Asn Gly Cys Gln Ser Ser Asn Asn His Tyr Trp Asp
          115            120            125
Asn Val Arg Arg Cys Leu Gly *
          130            135

```

(3) INFORMATION FOR SEQ ID NO:3:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 571 base pairs
 (B) TYPE: nucleic acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: DNA (genomic)

(iii) SEQUENCE DESCRIPTION: SEQ ID NO:3:

```

CTTGAGCTGA ACTGACAATC TTAATATCTC ACTG ATG AAT TAC GTT ATC TTT      52
                               Met Asn Tyr Val Ile Phe
                               1             5
GTG GTC TTA GTG GCA CTT TAC GTC ATC GAG GTA GCG AAG TGC ACC GTT      100
Val Val Leu Val Ala Leu Tyr Val Ile Glu Val Ala Lys Cys Thr Val
          10             15             20
CCA TCC GAC TGC TTG AGT TGC ATT TGC GAG GTA GAG GGA TGT GAC AAA      148
Pro Ser Asp Cys Leu Ser Cys Ile Cys Glu Val Glu Gly Cys Asp Lys
          25             30             35
GAG ATT GGA AGG TGC GGC GAT GAC GCA GGA AGT CTG AGC TGT GGT CCT      196
Glu Ile Gly Arg Cys Gly Asp Asp Ala Gly Ser Leu Ser Cys Gly Pro

```

40	45	50	
TAC CAG ATC AAG GAG CCC TAC TGG ATT GAC TGT GGA AGT CCA GGA GCA			244
Tyr Gln Ile Lys Glu Pro Tyr Trp Ile Asp Cys Gly Ser Pro Gly Ala			
55	60	65	70
GGA TAC CAG GAG TGC ACT AAG GAG AAG GCA TGT TCC GAA ACG TGT GTC			292
Gly Tyr Gln Glu Cys Thr Lys Glu Lys Ala Cys Ser Glu Thr Cys Val			
75	80		85
NAC NCT TAC ATG GAC AGG TAT NCC ACA AGG TGT ACT CGA GGN NNN NAA			340
Xaa Xaa Tyr Met Asp Arg Tyr Xaa Thr Arg Cys Thr Arg Gly Xaa Xaa			
90	95		100
CCG ACC TGC CAA GAC TAC GCC AAA ATT CAC AAC ATG GGA CCG AAC GGG			388
Pro Thr Cys Gln Asp Tyr Ala Lys Ile His Asn Met Gly Pro Asn Gly			
105	110		115
TGC AGA CGT ACG AGC AAC ACC TAC TGG AAC AAA GCC AAT GCG TGT CTG			436
Cys Arg Arg Thr Ser Asn Thr Tyr Trp Asn Lys Ala Asn Ala Cys Leu			
120	125		130
AAC TGAACAAGAC ATTATCGTCA GCTTCAGTCT GCCATCGTCT TTAAAGATGG			489
Asn			
135			
NNGCTCTCAA ATTCTAAATT GTAAAGAGAT TTCTACAGAC AGAATTATTA GTTGAATTTT			549
TAATAAATTA TATTAAAATT GT			571

(4) INFORMATION FOR SEQ ID NO:4:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 135 amino acids
- (B) TYPE: amino acid
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

(iii) SEQUENCE DESCRIPTION: SEQ ID NO:4:

Met Asn Tyr Val Ile Phe Val Val Leu Val Ala Leu Tyr Val Ile Glu	
1	15
Val Ala Lys Cys Thr Val Pro Ser Asp Cys Leu Ser Cys Ile Cys Glu	
20	30
Val Glu Gly Cys Asp Lys Glu Ile Gly Arg Cys Gly Asp Asp Ala Gly	
35	45
Ser Leu Ser Cys Gly Pro Tyr Gln Ile Lys Glu Pro Tyr Trp Ile Asp	
50	60
Cys Gly Ser Pro Gly Ala Gly Tyr Gln Glu Cys Thr Lys Glu Lys Ala	
65	80
Cys Ser Glu Thr Cys Val Xaa Xaa Tyr Met Asp Arg Tyr Xaa Thr Arg	
85	95

83

Cys Thr Arg Gly Xaa Xaa Pro Thr Cys Gln Asp Tyr Ala Lys Ile His
100 105 110

Asn Met Gly Pro Asn Gly Cys Arg Arg Thr Ser Asn Thr Tyr Trp Asn
115 120 125

Lys Ala Asn Ala Cys Leu Asn
130 135

(5) INFORMATION FOR SEQ ID NO:5:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 630 base pairs
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: DNA (genomic)

(iii) SEQUENCE DESCRIPTION: SEQ ID NO:5:

AGTAATGAAA ATTCACCTTT CGGACAAGG ATG ATC ATT GCA ATT TAT GTT TCC	53
Met Ile Ile Ala Ile Tyr Val Ser	
1 5	
CTA GCT CTT CTA ATC GCC TCT GTG GAG GTG AAT AGC CAA TTC ACT GAT	101
Leu Ala Leu Leu Ile Ala Ser Val Glu Val Asn Ser Gln Phe Thr Asp	
10 15 20	
TCT TGC CTT CGG TGT ATT TGC AAG GTG GAA GGA TGT GAC AGT CAA ATT	149
Ser Cys Leu Arg Cys Ile Cys Lys Val Glu Gly Cys Asp Ser Gln Ile	
25 30 35 40	
GGA AAA TGT GGA ATG GAT GTT GGA AGC TTG AGT TGC GGA CCA TAC CAG	197
Gly Lys Cys Gly Met Asp Val Gly Ser Leu Ser Cys Gly Pro Tyr Gln	
45 50 55	
ATT AAG AAA CCG TAC TGG ATT GAT TGT GGA AAA CCA GGG GGA GGT TAC	245
Ile Lys Lys Pro Tyr Trp Ile Asp Cys Gly Lys Pro Gly Gly Gly Tyr	
60 65 70	
GAA TCA TGC ACA AAA AAT AAA GCC TGT TCA GAG ACT TGT GTG AGA GCT	293
Glu Ser Cys Thr Lys Asn Lys Ala Cys Ser Glu Thr Cys Val Arg Ala	
75 80 85	
TAC ATG AAG AGG TAT GGA ACC TTC TGC ACA GGT GGA CGA ACC CCA ACC	341
Tyr Met Lys Arg Tyr Gly Thr Phe Cys Thr Gly Gly Arg Thr Pro Thr	
90 95 100	
TGC CAG GAT TAT GCT AGG ATT CAT AAC GGT GGA CCA CGC GGT TGC AAG	389
Cys Gln Asp Tyr Ala Arg Ile His Asn Gly Gly Pro Arg Gly Cys Lys	
105 110 115 120	
AGT TCT GCT ACT GTT GGT TAC TGG AAC AAG GTA CAG AAA TGT TTG AGA	437
Ser Ser Ala Thr Val Gly Tyr Trp Asn Lys Val Gln Lys Cys Leu Arg	
125 130 135	
TGAATTCGAA ATCTTTGAGT AGCNCCTGTC TTACATTTGA AAGGCCTTTT AATTCAAAAT	497
TATTTTGGGA ATCNAATGAT TTAAACATT TATTTGAAAT TATTCNGAAA TAGAAACAAC	557

SUBSTITUTE SHEET (RULE 26)

TATAAATTGC TCCAAGAATT GTATAATCAT GAAGTGTGTTG AAAGCTGTTT TCTGAAATAA 617
 ACTTCCCATA AAT 630

(6) INFORMATION FOR SEQ ID NO:6:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 136 amino acids
- (B) TYPE: amino acid
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

(iii) SEQUENCE DESCRIPTION: SEQ ID NO:6:

Met Ile Ile Ala Ile Tyr Val Ser Leu Ala Leu Leu Ile Ala Ser Val
 1 5 10 15
 Glu Val Asn Ser Gln Phe Thr Asp Ser Cys Leu Arg Cys Ile Cys Lys
 20 25 30
 Val Glu Gly Cys Asp Ser Gln Ile Gly Lys Cys Gly Met Asp Val Gly
 35 40 45
 Ser Leu Ser Cys Gly Pro Tyr Gln Ile Lys Lys Pro Tyr Trp Ile Asp
 50 55 60
 Cys Gly Lys Pro Gly Gly Gly Tyr Glu Ser Cys Thr Lys Asn Lys Ala
 65 70 75 80
 Cys Ser Glu Thr Cys Val Arg Ala Tyr Met Lys Arg Tyr Gly Thr Phe
 85 90 95
 Cys Thr Gly Gly Arg Thr Pro Thr Cys Gln Asp Tyr Ala Arg Ile His
 100 105 110
 Asn Gly Gly Pro Arg Gly Cys Lys Ser Ser Ala Thr Val Gly Tyr Trp
 115 120 125
 Asn Lys Val Gln Lys Cys Leu Arg
 130 135

(7) INFORMATION FOR SEQ ID NO:7:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 115 amino acids
- (B) TYPE: amino acid
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

(iii) SEQUENCE DESCRIPTION: SEQ ID NO:7:

Thr Val Pro Ser Asp Cys Leu Arg Cys Ile Cys Gln
 1 5 10
 Val Glu Gly Cys Asn Asn Glu Ile Gly Arg Cys Gly Met Asp Ala Gly
 15 20 25

85

Ser Leu Ser Cys Gly Pro Tyr Gln Ile Lys Glu Pro Tyr Trp Ile Asp
30 35 40

Cys Gly Arg Pro Gly Gly Gly Tyr Gln Gln Cys Thr Lys Glu Lys Ala
45 50 55 60

Cys Ser Glu Thr Cys Val His Ala Tyr Met Asp Arg Tyr Ala Arg Arg
65 70 75

Cys Thr Gly Gly Arg Gln Pro Thr Cys Gln Asp Tyr Ala Lys Ile His
80 85 90

Asn Met Gly Pro Asn Gly Cys Gln Ser Ser Asn Asn His Tyr Trp Asp
95 100 105

Asn Val Arg Arg Cys Leu Gly
110 115

What is claimed is:

1. A cleaning composition comprising an isopeptidase active amount of isopeptidase enzyme.
2. A laundry detergent compositions comprising:
 - a) from 0.0001% to 5%, preferably from 0.001% to 2%, by weight of an isopeptidase enzyme; and
 - b) from 95% to 99.9999% by weight of detergent composition adjunct ingredients.
3. A laundry detergent composition comprising:
 - a) from 0.1% to 80%, preferably from 1% to 50%, by weight of deterative surfactant;
 - b) from 0.0001% to 5%, preferably from 0.001% to 2%, by weight of an isopeptidase enzyme; and
 - c) from 0.1% to 99.8% by weight of detergent composition adjunct ingredients.
4. A laundry detergent compositions comprising:
 - a) from 0.0001% to 2% by weight of active deterative enzyme, preferably selected from the group consisting of proteases, cellulases, lipases, amylases, peroxidases, and mixtures thereof;
 - b) from 0.0001% to 5%, preferably from 0.001% to 2%, by weight of an isopeptidase enzyme; and
 - c) from 0.1% to 99.8% by weight of detergent composition adjunct ingredients, preferably selected from deterative surfactants, builders, and mixtures thereof.

5. A granular detergent compositions comprising:
 - a) from 0.1% to 50% by weight of a bleaching agent;
 - b) from 1% to 80% by weight of a builder selected from the group consisting of aluminosilicates, silicates, and mixtures thereof;
 - c) from 0.0001% to 2% by weight of active deterative enzyme selected from the group consisting of proteases, amylases, lipases, cellulases, and mixtures thereof;
 - d) from 0.0001% to 5%, preferably from 0.001% to 2%, by weight of an isopeptidase enzyme; and
 - e) from 0.1% to 99.8% by weight of detergent composition adjunct ingredients.
6. A laundry detergent composition according to any of Claims 1-5 comprising a builder, deterative surfactant, or mixtures thereof, wherein the builder is selected from the group consisting of aluminosilicates, silicates, phosphates, phosphonates, and mixtures thereof; and wherein further the surfactant is selected from the group consisting of alkyl alkoxylated sulfates, alkyl sulfates, linear alkyl benzenesulfonate surfactants, cationic surfactants, nonionic surfactants, amphoteric surfactants, zwitterionic surfactants, and mixtures thereof.
7. A laundry detergent composition according to any of Claims 1-6 in granular form.
8. A method for laundering fabrics, said method comprising contacting in a laundry machine a fabric in need of cleaning with an aqueous solution comprising an isopeptidase active amount of an isopeptidase enzyme.
9. A method for laundering fabrics, said method comprising contacting in a laundry machine a fabric in need of cleaning with an aqueous solution comprising an isopeptidase enzyme-containing composition according to any of Claims 1-7.
10. A method for hand laundering fabrics, said method comprising soaking a fabric in need of cleaning in an aqueous solution comprising an isopeptidase active amount of an isopeptidase enzyme.

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